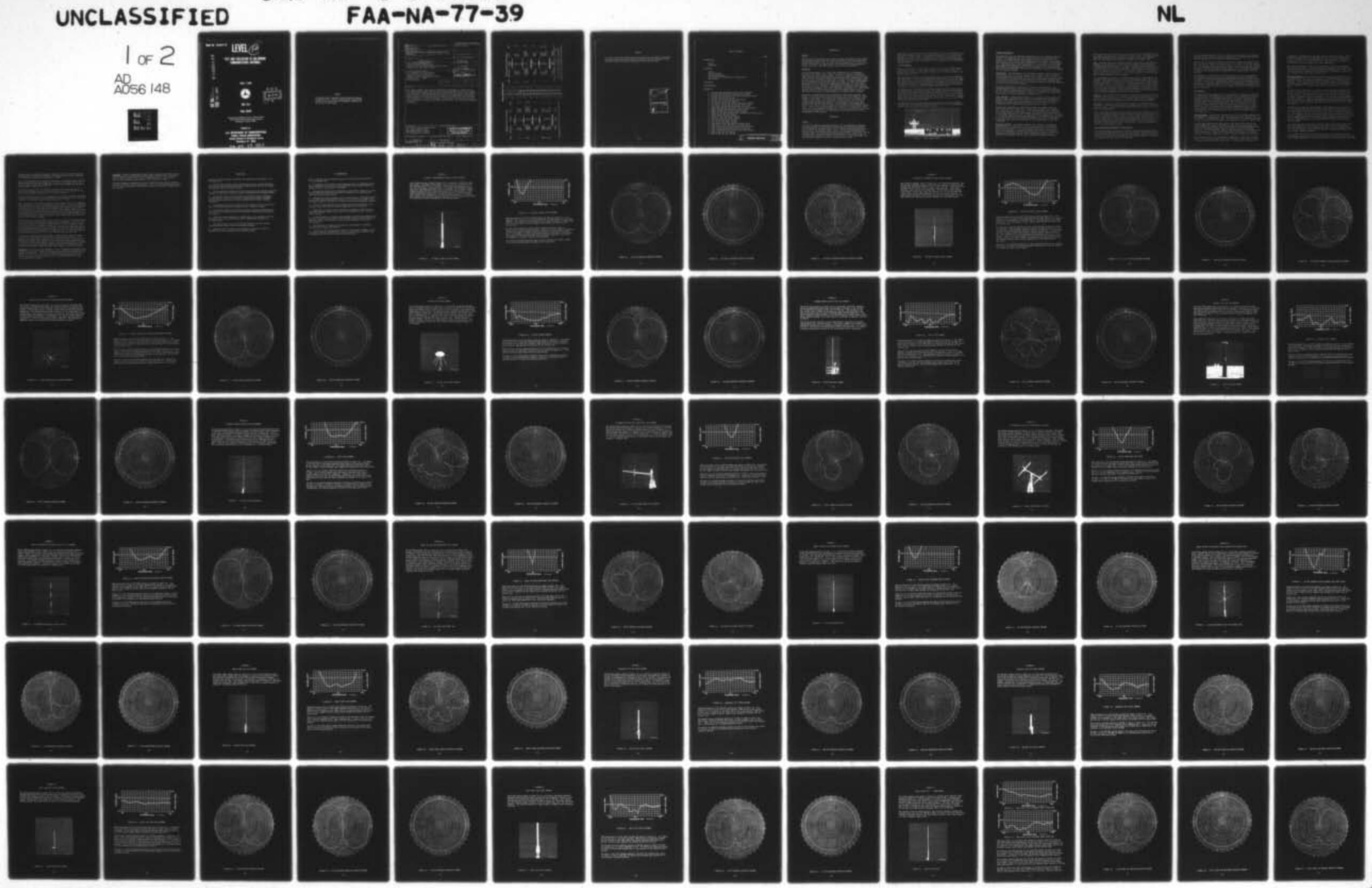
AD-A056 148 NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER ATL--ETC F/G 17/7
TEST AND EVALUATION OF AIR/GROUND COMMUNICATIONS ANTENNAS.(U)
JUN 78 J J COYLE
UNCLASSIFIED FAA-NA-77-39 NL

1 OF 2
AD
A056 148



Report No. FAA-NA-77-39

LEVEL II (12)

AD A056148

TEST AND EVALUATION OF AIR/GROUND COMMUNICATIONS ANTENNAS

James J. Coyle

AD No.
DDC FILE COPY

JUNE 1978

FINAL REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D.C. 20590

78 07 17 028

NOTICE

Technical Report Documentation Page

14 1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-NA-77-39		

6 4. Title and Subtitle	5. Report Date
TEST AND EVALUATION OF AIR/GROUND COMMUNICATIONS ANTENNAS.	
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
10 James J. Coyle	FAA-NA-77-39
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08232	11. Contract or Grant No. 062-221-100
12. Sponsoring Agency Name and Address	9 13. Type of Report and Period Covered
U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590	Final rept. January-December 1977
	14. Sponsoring Agency Code

15. Supplementary Notes

11 Jun 78 12 131p.

16. Abstract

This report presents data from the evaluation and analysis of a select group of very high frequency (VHF) and ultrahigh frequency (UHF) Air/Ground (A/G) communication antennas. Antenna patterns, gain, and voltage standing wave ratio measurements were made at the National Aviation Facilities Experimental Center (NAFEC) antenna range on both Federal Aviation Administration (FAA) specified and commercially available off-the-shelf antennas. These antenna data show that improved A/G communications coverage can be obtained with some of the commercially available antennas.

17. Key Words	18. Distribution Statement
Air Traffic Control Communications Air/Ground Communications VHF Communications Antennas UHF Communications Antennas	DISTRIBUTION STATEMENT A Approved for public release; Distribution Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	123	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

240 550 78 07 17 028 JOB

METRIC CONVERSION FACTORS

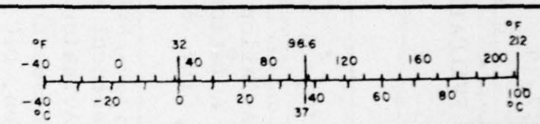
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

The author gratefully acknowledges the contributions and technical assistance provided by Norman Beauregard, Ronald Morgenweck, and Fred Wahlquist of the National Aviation Facilities Experimental Center antenna range.

TABLE OF CONTENTS

INTRODUCTION

PURPOSE.

The purpose of this project was to test, evaluate, and analyze a select group of very high frequency (VHF) and ultrahigh frequency (UHF) air/ground (A/G) communications antennas, and to obtain antenna reference data for use in the design, development and specification of an improved radiating system for enroute, terminal, and flight service station A/G communications.

BACKGROUND.

The continuing growth in air traffic has brought about a corresponding increase in the number of A/G channels required for enroute, terminal and flight service station communications. To provide additional A/G communications channels, the Federal Aviation Administration (FAA) Administrator issued a notice of policy decision in May 1973, to reduce the spacing between existing A/G channels from 50 kilohertz (kHz) to 25 kHz. To reduce radiofrequency interference (RFI) caused by collocated FAA transmitters, FAA Order 6610.3, dated April 17, 1975, authorized communications transmitter output power to be reduced from 50 to 10 watts. The combination of additional A/G communications channel assignments with narrow bandwidth requirements for 25 kHz channel spacing, and the 7 decibel (dB) reduction in transmitter power output has increased the problem of providing adequate A/G communications coverage.

Along with the modernization and replacement of obsolescent equipment, the present A/G communications system requires many other improvements to reflect changes in technology. This project was established to test, evaluate and analyze a select group of off-the-shelf, state-of-the-art, VHF and UHF A/G communications antennas and compare their operating characteristics with current in-use FAA specified antennas. Many different type antennas were tested at the National Aviation Facilities Experimental Center (NAFEC) antenna range. Some of the test measurements are included in the appendices to this report to serve as antenna reference data. The use of a specific manufacturers' antenna was considered to be a representative type antenna only and not an endorsement of their product.

DISCUSSION

GENERAL.

Most FAA A/G communications sites presently use the elliptically polarized (swastika) antenna for transmitting service, and the vertically polarized coaxial dipole for receiving service in the VHF A/G communications frequency band of 118 to 136 megahertz (MHz). Also, a vertically polarized discone antenna is used for communications with military aircraft in the 225 to 400 MHz frequency band. Other type FAA specified antennas can be found at some A/G communications facilities; however, they constitute a small percentage of the total antenna complement and are not covered in this report.

Commercially available antennas have been installed at A/G communication facilities with coverage problems. A representative sample of these nonstandard antennas was tested at NAFEC and compared with FAA specified antennas. The results of this test effort are included in this report to provide reference data for use in the design and specification of an improved A/G communications radiating system.

TEST ENVIRONMENT.

The test measurements included in this report were made at the NAFEC antenna range shown in figure 1. This range consists of a transmitter site and receiver site located approximately 1,000 feet apart on opposite sides of the Atlantic City reservoir.

The transmitter site has a Rohde and Schwarz signal source type SLSV·BN41002 that was adjusted to provide a radiofrequency (RF) continuous wave (CW) signal of 5 volts into a 50 ohm source antenna at test frequencies of 118, 127, 136, 225, 300, and 400 MHz. The source antenna, a Scientific-Atlanta Series 26 log-periodic dipole array, was mounted on an adjustable positioning mechanism to permit the changing of antenna alignment and polarization.

The receiver site contained the test antenna positioning and control system, receiving system, and pattern recorder. The antenna positioner consisted of an Ant Lab azimuth-over-elevation pedestal mounted on top of a 30-foot tower and connected to position indicators, remote direction controls, and variable speed controls located inside the trailer at the base of the tower. A rotary joint in the antenna pedestal permits the antenna under test to rotate freely without disconnecting the feed cable.

The receiving system, a Scientific-Atlanta Series 1640 precision amplitude receiver, has a 40 dB dynamic range with a bolometer output for operating the Scientific-Atlanta Series 1530A polar recorder.

FIGURE 1. NAFEC ANTENNA RANGE

ANTENNA MEASUREMENTS.

An antenna is one of the principle components in the A/G radiating system and serves as the connecting link between free space and the transmitter or receiver by transforming the electromagnetic energy contained in the transmission line to that of free-space propagation or vice versa. The parameters most often used to describe antenna properties are polarization, input impedance, radiation pattern, gain, and bandwidth. A description of the antenna measurements and measurement techniques are included in this section of the report while the measurement data for each antenna are included in the appendix for that specific antenna.

POLARIZATION. The polarization of an antenna is defined by the orientation of the electric vector of the wave radiated by the antenna. Thus, a vertical dipole antenna above ground will radiate vertical polarization and have a circular pattern in the horizontal (H) plane and a figure-eight (cosine) pattern in the vertical (E) plane. Vertical polarization offers the advantage that interference phenomena which may occur between the direct ray and the reflected ray are for the most part eliminated.

The design polarization of emissions for VHF A/G communications in the International Aeronautical Mobile Service is vertical. Many FAA facilities use the swastika antenna which has elliptical polarization (both horizontal and vertically polarized components); however, it is planned to replace them with vertically polarized antennas in the near future.

INPUT IMPEDANCE. Antenna input impedance is the parameter which relates the antenna to the transmission line and is used to measure the efficiency of energy transfer into or from the antenna. All FAA specified antennas were designed to operate with a 50 ohm impedance and have an initial voltage standing wave ratio (VSWR) tolerance/limit of 2.0:1 or less.

Antenna input impedance was determined with VSWR measurements using the Alford Model 1026C-6 slotted line, a Hewlett-Packard Model 415-E standing wave ratio meter, and a Smith Chart. All VSWR measurements were made with each antenna mounted 30 feet above ground on a crank-up tower and connected to the slotted line with a 50 foot length of RG-214/U coaxial cable. To obtain a true antenna VSWR (at the antenna terminals) a 2.0:1 mismatch was installed on the end of the 50-foot cable and this VSWR value was used to calibrate the standing wave ratio meter readings for cable attenuation at the test frequencies.

RADIATION PATTERNS. The radiation pattern of an antenna is a graphical representation of the magnitude of the relative electric field strength radiated from an antenna in a given plane, plotted against the direction from a given reference. A free-space radiation pattern is required as a basis for determining the antenna performance even though in an operating environment reflections from the antenna supporting structure, other antennas, and extraneous objects cause considerable pattern distortion.

Both H-plane and E-plane radiation patterns were made for each antenna at the low, center, and high end of its designed frequency range. The center frequency radiation patterns for each antenna are included in the report appendices, while all other patterns are available at NAFEC in the project file.

GAIN. The power gain of an antenna is defined as the ratio of the radiation intensity of the antenna in a given direction (usually on the horizon) to the maximum radiation intensity of a lossless reference antenna (usually a half-wave dipole) with the same input power. Antenna gain is usually expressed in dB over the gain of a lossless half-wave dipole (dBd), or in dB over the gain of an isotropic radiator (dBi). The isotropic radiator is a hypothetical antenna which radiates uniformly in all directions and has 2.15 dB less gain than a lossless half-wave dipole antenna.

Gain measurements were made at the NAFEC antenna range by comparing the test antennas to the Scientific-Atlanta Series 15 adjustable standard gain dipole antennas. The Series 15 standard gain antennas have moveable elements which permit their length to be adjusted to a half-wavelength at the test frequency. An adjustable coaxial balun-impedance transformer within the antenna support mast is used to match the adjustable antenna elements to the 50 ohm transmission line. When the dipole elements and balun-impedance transformer are set to the etched test frequency calibration marks, these Series 15 antennas have gains of a half-wavelength dipole (0 dBd or +2.15 dBi).

BANDWIDTH. The bandwidth of an antenna is the frequency range over which the antenna performs within all the electrical performance specifications. Many factors, such as the deterioration of impedance characteristic, change in pattern shape, and loss of gain are used to determine antenna bandwidth.

ISOLATION. Isolation in a multiantenna environment is obtained by either physically or electrically separating the radiated waves that are interacting with each other. Isolation from the antenna supporting structure is also an important consideration.

Vertical stacking of antennas is one method of achieving isolation in a limited space. The multiple dipole collinear array concept, used by the Technical Appliance Corporation (TACO), employs vertical stacking with a method of shielding the feed cables to improve radiation pattern characteristics and also achieve a high degree of isolation between antennas in a closely spaced array. The TACO collinear array antennas tested at NAFEC consisted of the D-2212 (VHF-VHF), D-2213 (UHF-VHF), D-2260 (VHF-VHF-VHF) D-2118 (UHF-VHF-UHF) and the D-2218 (VHF-UHF-VHF) antennas.

INSTALLATION AND ENVIRONMENTAL CONSIDERATIONS.

A realistic approach in improving the FAA A/G radiating system must involve more than just using efficient and effective antennas. When deciding which antenna would be best for a specific application, many factors such as cost, size, weight, installation requirements, environmental problems, reliability, and expected life cycle become very important.

The FAA uses approximately 25,000 A/G communications antennas in the National Airspace System. Therefore, any small increase in cost becomes very significant when multiplied by the number of antennas required.

Antenna size and weight are important factors when considering shipping, storage, handling, and installation requirements. The ability of one man, working alone, in adverse weather conditions, to repair or replace a defective antenna is a most important installation consideration. Most FAA antennas are presently installed on standard mounting brackets, therefore, the mounting requirements for any new type antenna should be compatible with these brackets if at all possible.

The antenna is a passive device with no moving parts to wear out, therefore, it is reasonable to expect that a new type antenna using state-of-the-art techniques to overcome environmental problems should provide at least 20 years of trouble free service. Environmental problems such as wind loading, weather fatigue, ice conditions, chemical decomposition, and galvanic corrosion due to the action of dissimilar metals in a salt air environment are important factors which relate to the reliability and the expected life cycle of an antenna and must be considered.

TEST RESULTS.

The antenna range measurement data in the appendices of this report show that an improvement in A/G communications coverage could be obtained by replacing the FAA specified VHF broadband coaxial dipole and elliptically polarized (swastika) antennas with commercially available antennas. Communications coverage flight test measurements at NAFEC and at various field facilities have shown that a significant improvement occurred when some of these nonstandard antennas were used to replace the FAA specified antennas. These flight test data can be found in the Advanced Communications Systems Support Project report, prepared by the Verve Research Corporation under Contract DOT-FA75WA1-570, in the NAFEC Technical Letter Report NA-77-60-LR, and in the project file.

INPUT IMPEDANCE. Antenna input impedance in the 118 to 400 MHz frequency band is measured by determining the type of mismatch the antenna produces when it is connected to a transmission line. The measurement of transmission line VSWR permits the determination of antenna input impedance by means of a Smith chart.

The VSWR measurements in the appendices of this report were made with the antenna under test, mounted on a crank-up tower 30 feet above ground, and clear of reflecting objects. VSWR is not constant along a transmission line; therefore, the VSWR measurement should be made at the antenna terminal. However, at many installations, making a VSWR measurement at the antenna terminal is impractical. When the VSWR measurement is not made at the antenna terminal, the change in SWR, due to cable attenuation, should be considered.

The HP-415E SWR meter was calibrated for change due to cable loss by installing a 2.0:1 mismatch element on the 50-foot length of cable used to connect the antenna under test to the slotted line. The dotted line in figure A-2

of appendix A illustrates that the 2.0:1 mismatch through the 50-foot length of RG-214 coaxial cable has a VSWR meter value of 1.67:1 at 118 MHz, and 1.65:1 at 136 MHz, due to cable attenuation. The dotted line in figure D-2 of appendix D shows the 2.0:1 mismatch has a VSWR meter value of 1.58:1 at 225 MHz, and 1.44:1 at 400 MHZ, due to cable attenuation.

When cable attenuation is taken into consideration, the following antenna VSWR values are obtained. The FA-5675 antenna in appendix C has a VSWR value of less than 2.0:1 at the antenna terminal between 119 MHz and 133 MHz. The Radionics antenna in appendix O has a VSWR value at the antenna of less than 2.0:1 across the 118 to 136 MHz frequency band.

RADIATION PATTERNS. Both the H-plane and the E-plane radiation patterns in the appendices of this report were made with the antennas mounted on a wooden support at least 5 feet above the antenna pedestal (12 feet above the tower platform). All patterns were made with the antenna under test operating in the receive mode. However, due to the principle of reciprocity, the results would be the same if the antennas under test were operating in the transmit mode.

An omnidirectional antenna is an antenna having an essentially nondirective pattern in azimuth and a directive pattern in elevation (ASA standard). The relative gain of an omnidirectional antenna in any azimuth direction should not vary from the mean value by more than ± 1.5 dB for 360° of rotation (EIA standard). Figures A-3 and A-4 in appendix A show the vertical and horizontal radiation pattern for a typical omnidirectional, vertically-polarized, half-wave dipole antenna. Figure B-3 and figure U-9 show distorted vertical radiation patterns caused by antenna currents flowing in the shield of the coaxial feed cable.

Figures A-5, B-5, and Q-4, were included in the appendices of this report to show the vertical pattern distortion that occurs when a 5-foot length of 1-1/4 inch aluminum mounting pipe was attached to the base of the antennas. The 25 dB loss of signal on the horizon shown in figure B-5 was caused by antenna current being coupled into the 5-foot mounting pipe directly beneath the antenna. This is a principle reason for coverage problems when this type antenna is used for A/G communications. The TACO D-2216 antenna (appendix Q) had the least amount of pattern distortion of all the broadband omnidirectional antennas tested at NAFEC.

Directional antennas can be used to improve coverage and reduce interference when the antenna site is not located in the center of the coverage area. Radiation patterns for directional antennas can be found in appendices H, I, K, V, and W. Appendix V also contains patterns of directional antennas when they are both stacked and skewed.

A directional antenna has one or more major lobes in the horizontal pattern whose maximum relative gain exceeds the minimum relative gain by more than 3 dB. The horizontal beamwidth of a directional antenna is the angular width, including

maximum radiation, measured between two points on the major lobe of the horizontal pattern 3 dB below the maximum. For example, the horizontal beamwidth of the DB-224E antenna shown in figure G-4 is 160°.

The vertical beamwidth of an antenna is defined as the angular width, including maximum radiation, measured between the two points on the major lobe of the vertical pattern 3 dB below the maximum. The vertical beamwidth of the DPV-22 antenna shown in figure E-3 is 14°.

The elevation beam tilt of an antenna is defined as the angle between the direction of maximum radiation and the horizontal plane. The beam tilt of the DPV-22 antenna shown in figure E-3 is 8° above the horizon.

The elevation beam tilt loss of an antenna is the difference between the maximum radiation and the radiation in the horizontal plane expressed in dB. The beam tilt loss of the DPV-22 antenna shown in figure E-3 is 4 dB.

GAIN. Antenna gain measurements included in this report were made by comparing the antenna under test to a standard gain dipole antenna. After each horizontal radiation pattern was made, the antenna under test was replaced by the standard gain antenna and a dot representing the standard gain antenna receive level was placed on the 0 or 90° radial. The gain of each antenna in dBd can be found by comparing the dB difference between the gain dot and the antenna under test radiation pattern level. The antenna gain in dBi can be found by adding 2.15 dB to the dBd measurement, however, in practice only integral dB values are used and the .15 dB value is dropped.

The principles of antenna design and how to direct or shape the radiation pattern to obtain effective radiated power gain are well established. Gain in an omnidirectional antenna is obtained by compressing the vertical radiation pattern closer to the horizon as shown in figures E-3, F-3, G-3, X-3, and Y-3. Gain in a unidirectional or bidirectional antenna is obtained by compressing the horizontal radiation pattern as shown in figures G-4, H-4, I-4, K-4, V-4, and W-4. The unidirectional yagi antenna array in appendix I can be made bidirectional by reversing the direction of one of the three element yagi sections.

To assist in making the gain measurements, a standard gain antenna reference level dot was also placed on some of the vertical radiation patterns. For example, the standard gain antenna reference level dot on the horizontal radiation pattern (figure E-4 of appendix E) for the DPV-22 antenna shows that this antenna has less than dipole gain. However, the standard gain antenna reference level dot on the vertical radiation pattern (figure E-3 of appendix E) shows the DPV-22 antenna has 4 dB of gain more than a dipole 8° above the horizon.

BANDWIDTH. An antenna that was designed to cover a broadband of frequencies will usually not have as low a VSWR or as much gain as an antenna designed for a narrowband of frequencies. Many of the broadband antennas tested at NAFEC with a VSWR of 2.0:1 or less across the 118 to 136 MHz frequency band had pattern distortion and loss of gain within the band. This condition was not found in the narrowband antennas.

ISOLATION. Isolation measurements between dipole elements in the TACO collinear array antennas were made with the antennas under test installed on a crank-up tower 30 feet above ground and clear of reflecting objects. The isolation between antenna elements measured greater than 30 dB in all cases.

Isolation between the antennas and a metalic supporting structure was investigated with radiation pattern measurements. Lack of isolation between the antennas and the supporting structure caused pattern distortion as shown in figures A-5, B-5, and Q-4.

CONCLUSIONS

Based on the data collected, evaluated, and presented in this report, it is concluded that:

1. FAA A/G communications antenna specifications do not include sufficient radiation pattern requirements and thereby have permitted the use of antennas with marginal radiation characteristics.

2. The FAA specified broadband VHF dipole and elliptically polarized (swastika) antennas are inefficient and could cause A/G communications coverage problems.

3. The broadband UHF discone and dipole antennas have similar operating characteristics. However, a VHF dipole antenna sealed inside a fiberglass enclosure should provide more reliable communications in adverse weather conditions.

4. The omnidirectional gain antennas tested at NAFEC that had a gain of more than +2 dBd become excessive in length and lost overhead coverage.

5. Directional antennas can be used to provide an effective radiated power (ERP) gain at FAA communications facilities where omnidirectional coverage is not required.

6. Isolation between antennas in a limited space can be increased by using an antenna with a low profile design and by stacking the antennas in a collinear manner.

7. Some VHF antennas with less than 18 MHz bandwidth had more suitable operating characteristics than the broadband antennas.

8. Additional test, evaluation, and analysis is required to define an optimum FAA Air/Ground Communications Radiating System.

RECOMMENDATIONS

Based on the test results obtained during this test and evaluation effort, it is recommended that:

1. In addition to polarization, input impedance, gain, and bandwidth, future FAA A/G communications antenna specifications should also include definitive radiation pattern and isolation requirements.

2. Broadband VHF antennas with performance characteristics equal to or better than the TACO D-2216 VHF dipole antenna be installed at A/G communications facilities with coverage problems.

3. Broadband UHF dipole antennas that are sealed inside a fiberglass enclosure and have performance characteristics equal to or better than the TACO D-2217 UHF dipole antenna be installed at field facilities with environmental problems.

4. The use of omnidirectional gain antennas should be restricted to those facilities where the cost and coverage requirements can be justified.

5. Directional A/G communications antennas be installed at FAA field facilities with coverage problems that could be corrected with the use of directional antennas.

6. A limited number of collinear array antennas with operating characteristics equal to or better than the TACO D-2212 (VHF-VHF) antenna, and the TACO D-2213 (UHF-VHF) antenna, be obtained and installed with additional on-site test and evaluation.

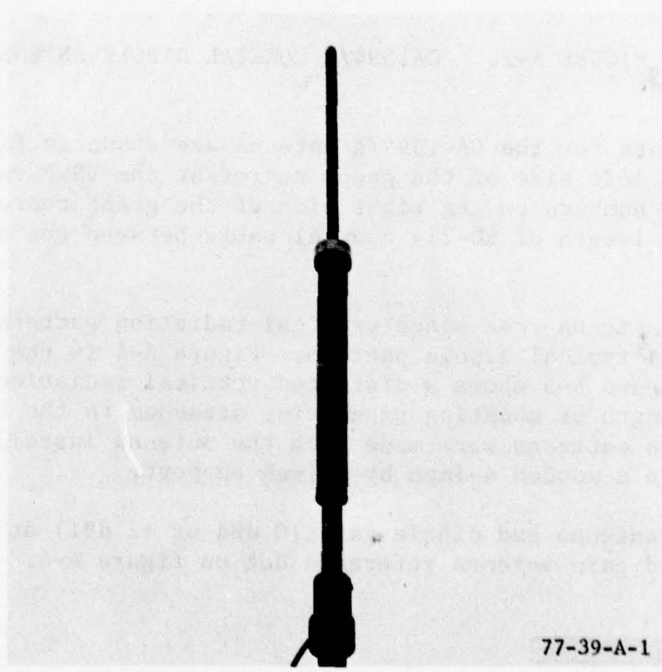
7. The usefulness of narrow band antennas be investigated for possible communications coverage improvements.

8. A long term test and evaluation project be established at NAFEC to define an optimum air/ground communications radiating system based on antenna range measurements and verified with flight test measurements.

APPENDIX A

CA-1594/A VHF NARROWBAND COAXIAL DIPOLE ANTENNA

The CA-1594/A antenna shown in figure A-1 is a vertically polarized, omnidirectional, narrowband coaxial dipole that was designed to operate in the VHF frequency band of 117 to 123 MHz. This antenna was manufactured for the Civil Aeronautics Administration by the Granite State Machine Company, Manchester, New Hampshire under contract CCA-32100. The CA-1594/A antenna weighs approximately 6 3/4 pounds and consists of a 22-inch long by 1-inch diameter radiating element and a 24 1/8-inch long by 2 1/2-inch diameter lower element skirt separated by a 2-inch porcelain insulator. A mounting pipe extends 12 inches below the skirt and has standard 1 1/4 inch pipe thread for attaching the antenna assembly to its mounting bracket.



77-39-A-1

FIGURE A-1. CA-1594/A COAXIAL DIPOLE ANTENNA

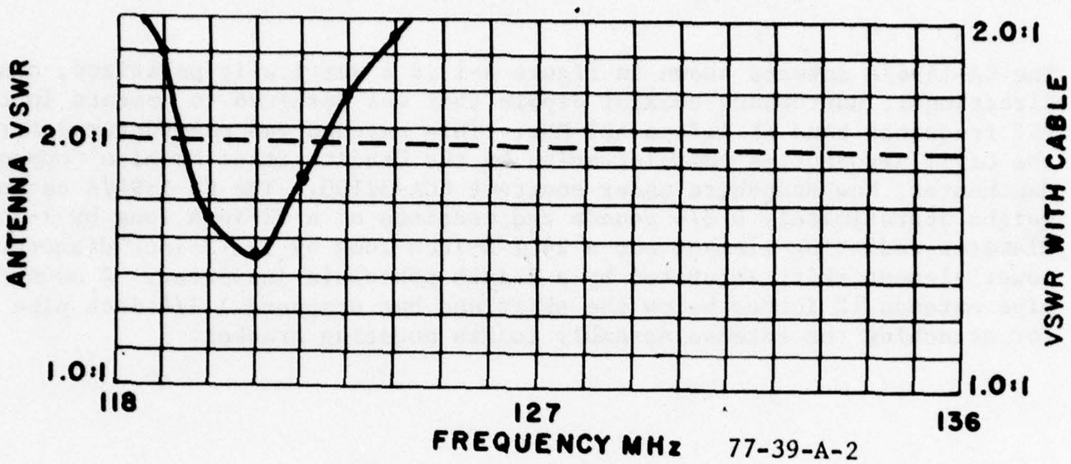


FIGURE A-2. CA1594/A COAXIAL DIPOLE ANTENNA

VSWR measurements for the CA-1594/A antenna are shown in figure A-2. The numbers on the left side of the graph represent the VSWR values at the antenna terminal. The numbers on the right side of the graph represent the VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

The CA-1594/A antenna free space vertical radiation pattern shown in figure A-3 is a typical dipole pattern. Figure A-4 is the horizontal radiation pattern and figure A-5 shows a distorted vertical radiation pattern caused by a 5 foot length of mounting pipe being attached to the base of the antenna. These radiation patterns were made with the antenna installed 5 feet above the pedestal on a wooden 4-inch by 4-inch support.

The CA-1594/A antenna had dipole gain (0 dBd or +2 dBi) at 120 MHz as shown by the standard gain antenna reference dot on figure A-4.

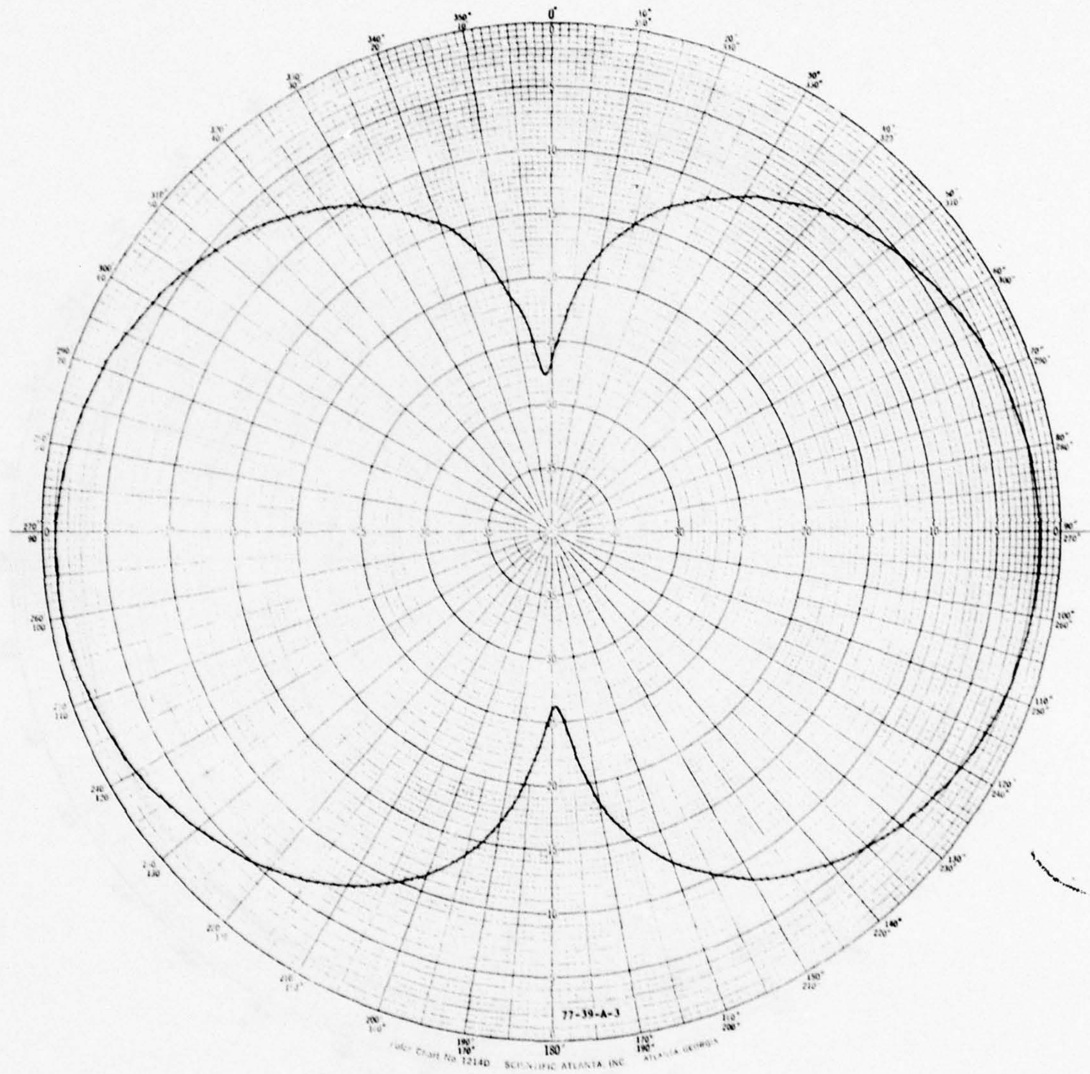


FIGURE A-3. CA-1594/A VERTICAL RADIATION PATTERN

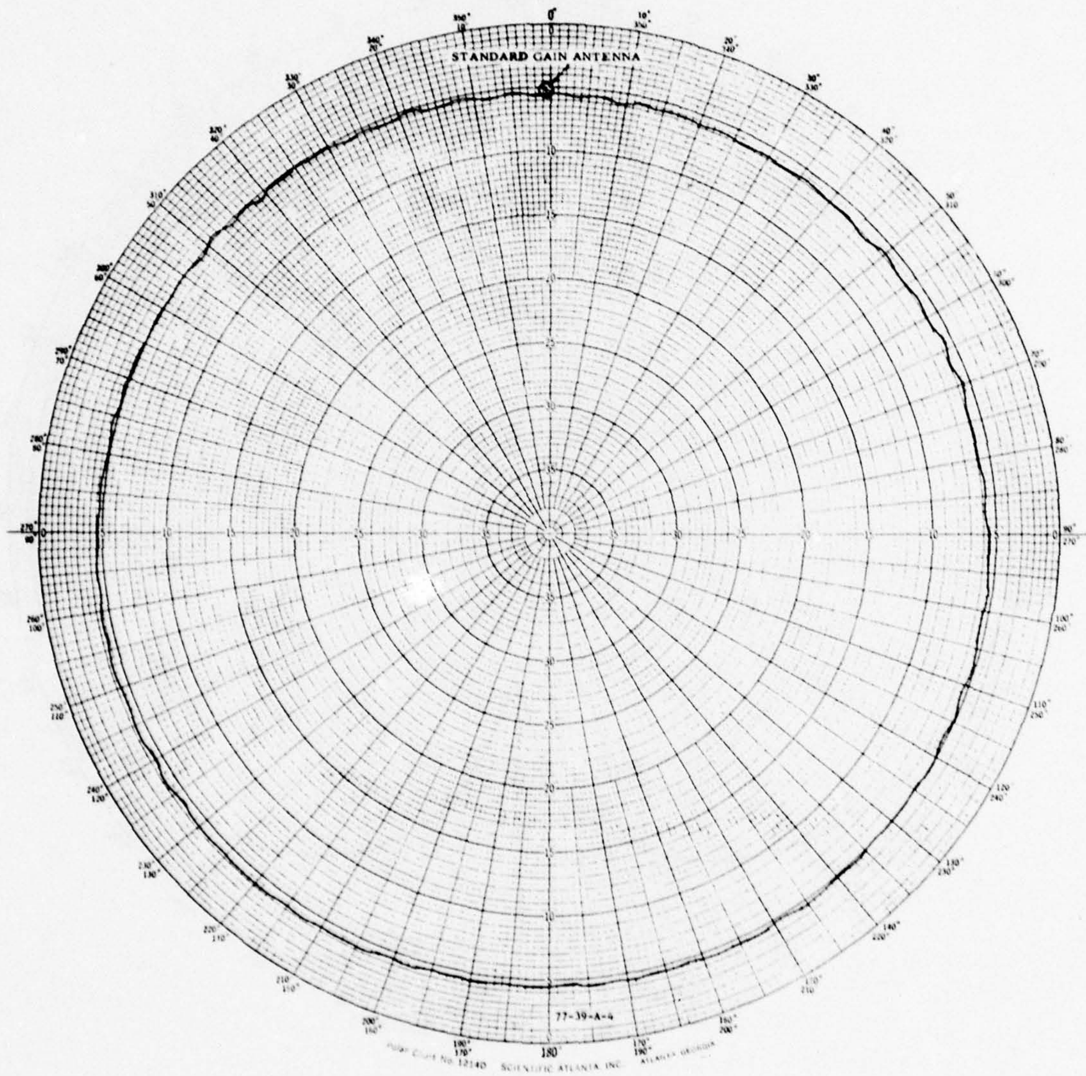


FIGURE A-4. CA-1594/A HORIZONTAL RADIATION PATTERN

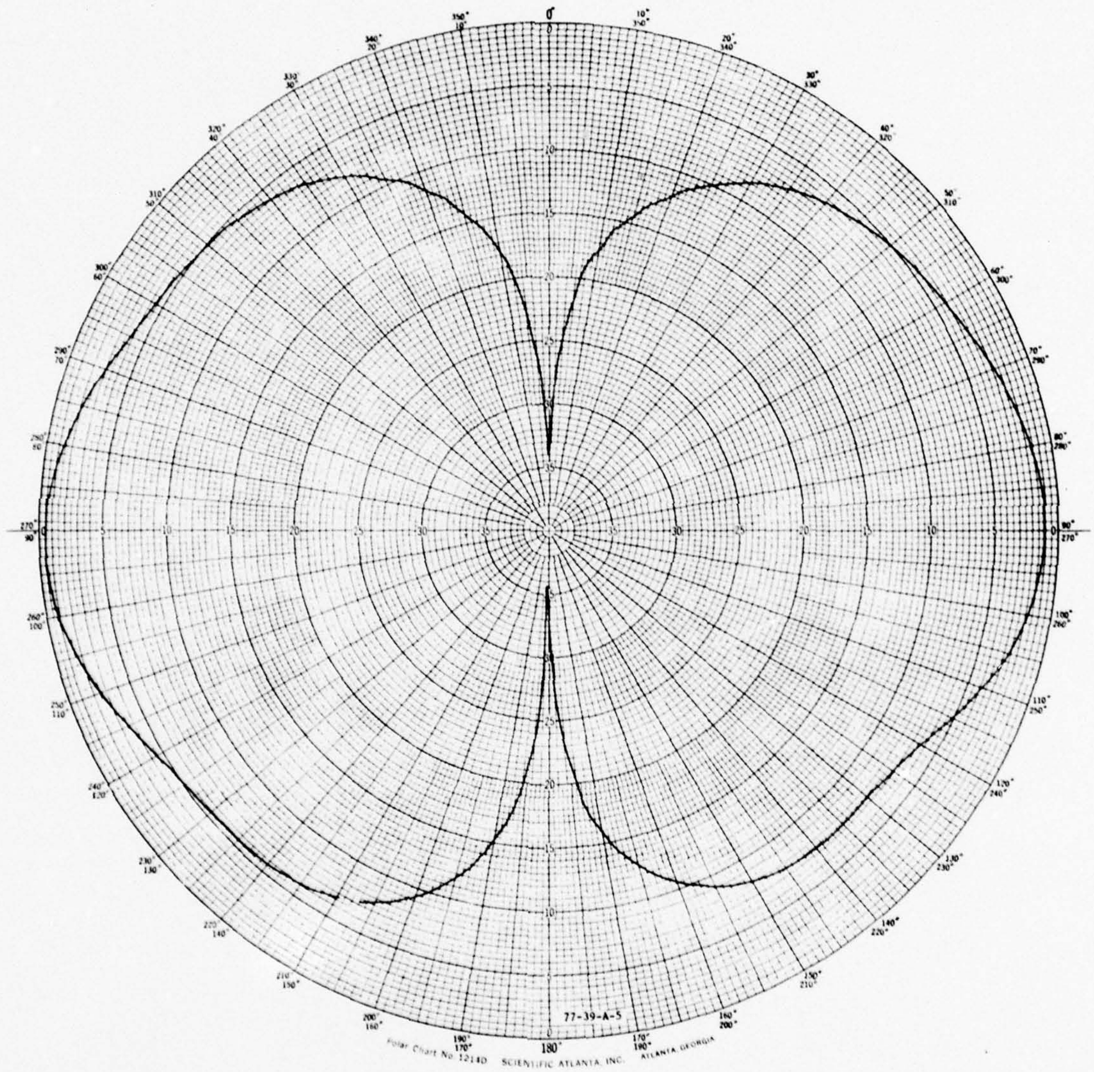


FIGURE A-5. CA-1594/A DISTORTED VERTICAL RADIATION PATTERN

APPENDIX B

FA-7957A VHF BROADBAND COAXIAL DIPOLE ANTENNA

The FA-7957/A antenna, shown in figure B-1, is a vertically polarized, omnidirectional, broadband coaxial dipole that was designed to operate in the extended VHF air/ground frequency band of 118 to 144 MHz. This antenna was manufactured for the FAA by R. A. Miller Industries Inc., Grand Haven, Michigan, under contract DOT-FA70WA-2366. The FA-7957/A antenna weighs 4 1/2 pounds, is 39 inches long, and consists of a 15 1/4-inch radiating element and a 15-inch skirt separated by a 2-inch ceramic insulator. A mounting pipe extends 6 inches below the skirt and has standard 1 1/4 inch pipe thread for attaching the antenna assembly to a mounting bracket.

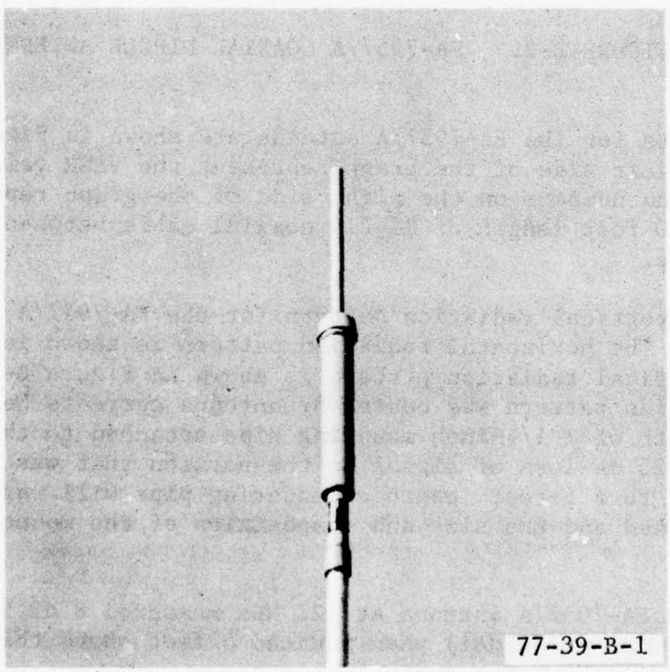


FIGURE B-1. FA-7957/A COAXIAL DIPOLE ANTENNA

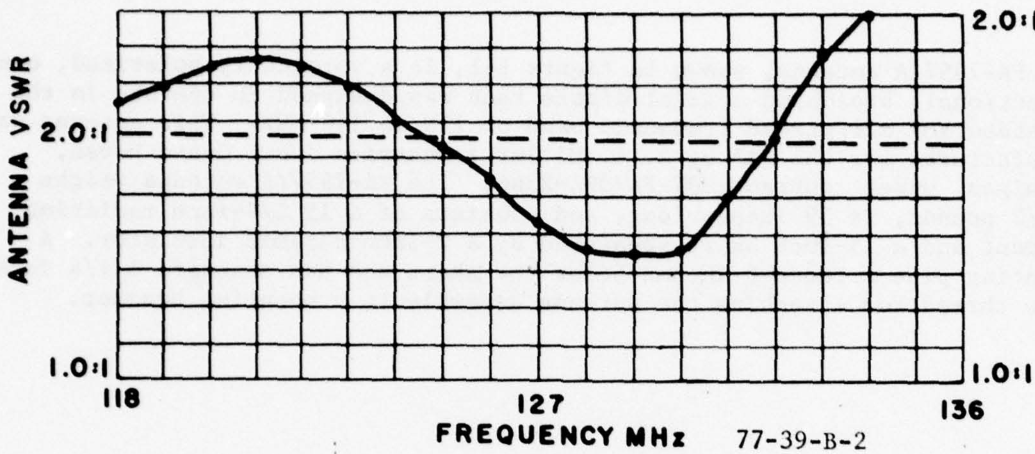


FIGURE B-2. FA-7957/A COAXIAL DIPOLE ANTENNA

VSWR measurements for the FA-7957/A antenna are shown in Figure B-2. The numbers on the left side of the graph represent the VSWR values at the antenna terminals and the numbers on the right side of the graph represent the VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

The free-space vertical radiation pattern for the FA-7957/A antenna is shown in figure B-3. The horizontal radiation pattern is shown in figure B-4, and a distorted vertical radiation pattern is shown in figure B-5. The distorted vertical radiation pattern was caused by antenna currents being coupled into the 5-foot length of 1 1/4-inch mounting pipe attached to the base of the antenna. This 25 dB loss of signal on the horizon that was caused by attaching the antenna to a 5-foot length of mounting pipe will vary depending upon the frequency used and the size and composition of the mounting pipe or structure.

The gain of the FA-7957/A antenna at 127 MHz measured 8 dB below the standard gain dipole (-8 dBd or -6 dBi) when mounted 5 feet above the antenna pedestal on a 4-inch by 4-inch wooden support.

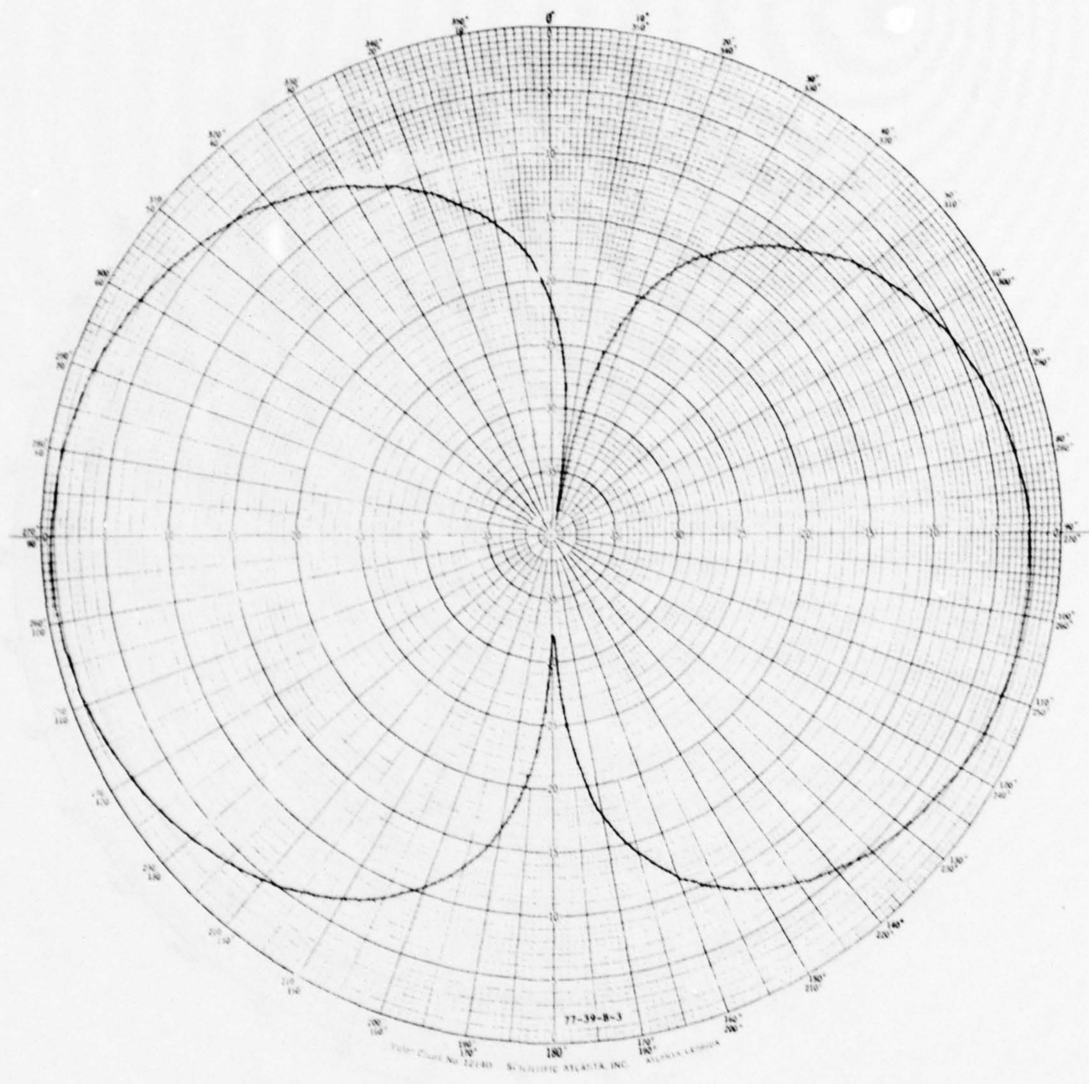


FIGURE B-3. FA-7957/A VERTICAL RADIATION PATTERN

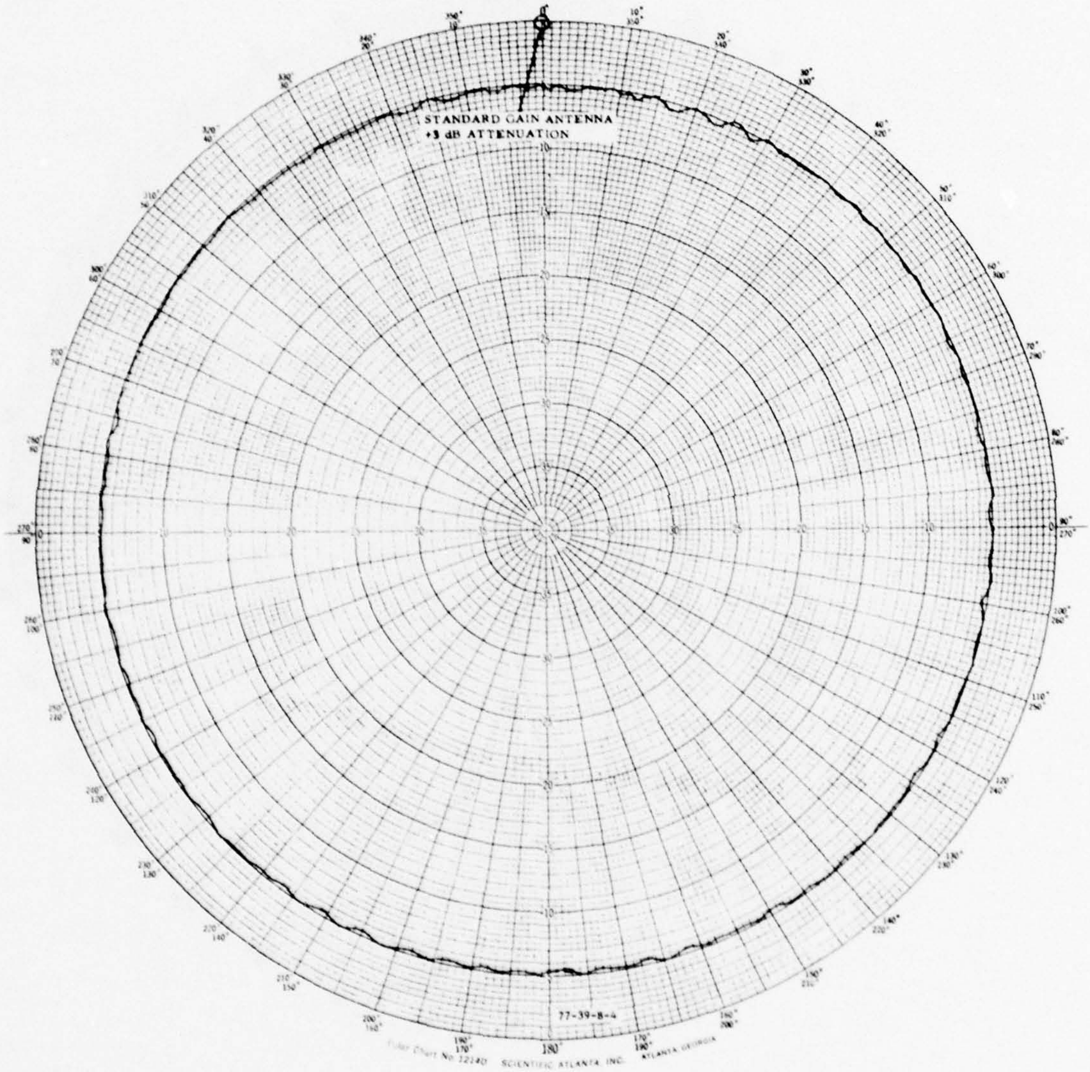


FIGURE B-4. FA-7957/A HORIZONTAL RADIATION PATTERN

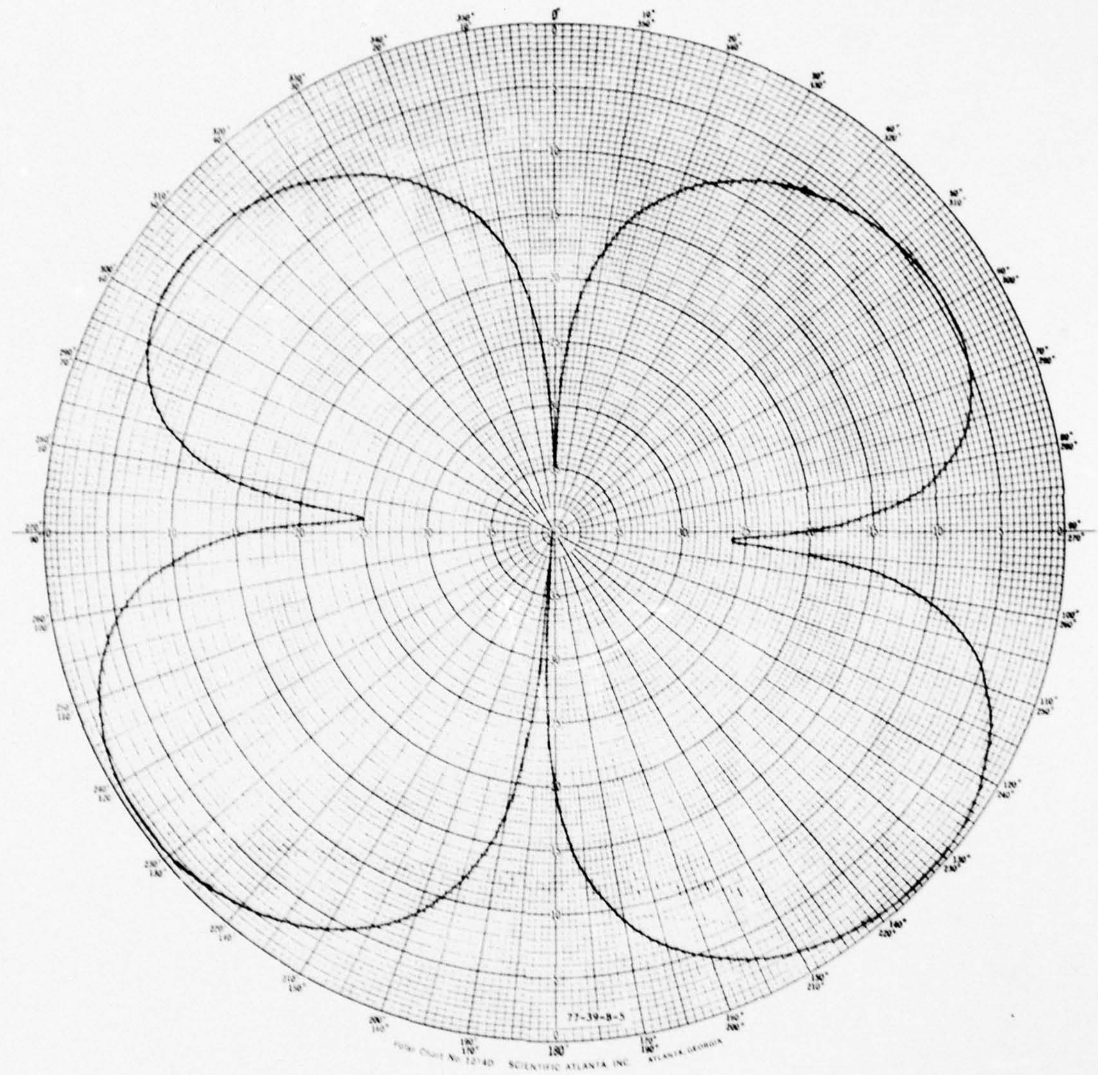
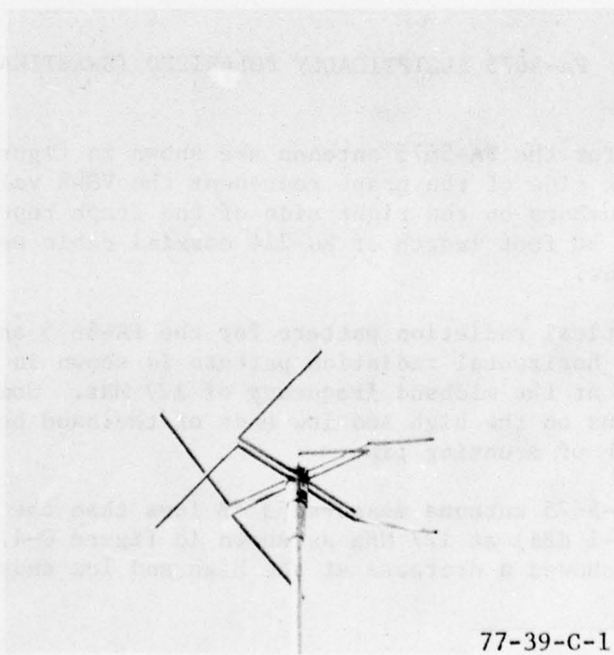


FIGURE B-5. FA-7957/A DISTORTED VERTICAL RADIATION PATTERN

APPENDIX C

FA-5675 VHF ELLIPTICALLY POLARIZED (SWASTIKA)ANTENNA

The FA-5675 antenna shown in figure C-1 is an elliptically polarized, omnidirectional, broadband antenna that was designed to operate in the VHF air/ground frequency band of 118 to 136 MHz. This antenna was manufactured for the FAA by the Antenna Products Company, Mineral Wells, Texas under contract FA65WA-1341. The FA-5675 antenna weighs 18 pounds, is 21 inches high, 36-inches square, and consists of an upper and lower hub, each having four dipole elements spaced approximately 1/3 wavelength apart at the midband frequency and inclined 30° with respect to the horizon. The upper and lower hubs are separated by a fiberglass reinforced plastic insulator. This antenna was designed to mount on a standard 2 1/2-inch galvanized iron pipe.



77-39-C-1

FIGURE C-1. FA-5675 ELLIPTICALLY POLARIZED ANTENNA

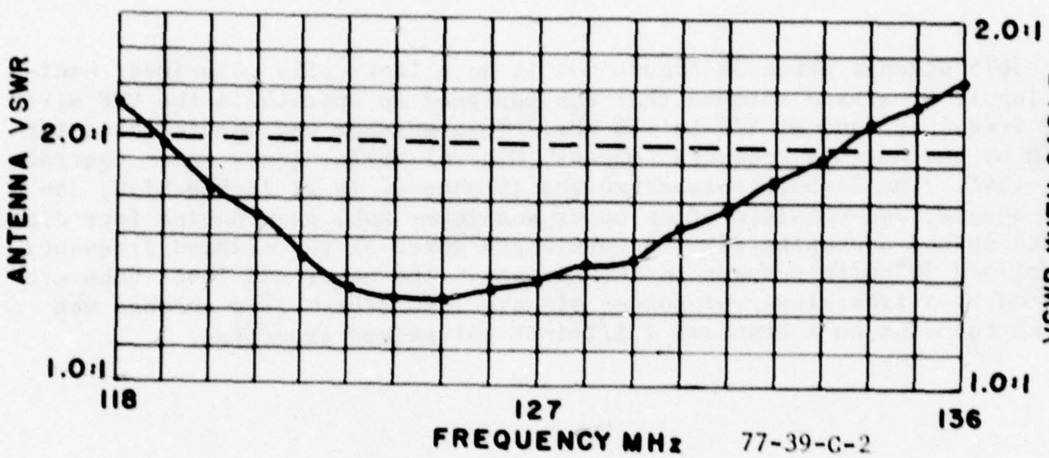


FIGURE C-2. FA-5675 ELLIPTICALLY POLARIZED (SWASTIKA) ANTENNA

VSWR measurements for the FA-5675 antenna are shown in figure C-2. The numbers on the left side of the graph represent the VSWR values at the antenna terminal and the numbers on the right side of the graph represent the antenna VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

The free-space vertical radiation pattern for the FA-5675 antenna is shown in figure C-3 and the horizontal radiation pattern is shown in figure C-4. These patterns were made at the midband frequency of 127 MHz. Some vertical pattern distortion was found on the high and low ends of the band both with and without a 5-foot length of mounting pipe.

The gain of the FA-5675 antenna measured 3 dB less than the standard gain dipole (-3 dBd or -1 dBi) at 127 MHz as shown in figure C-4. Antenna gain measurements also showed a decrease at the high and low ends of the band.

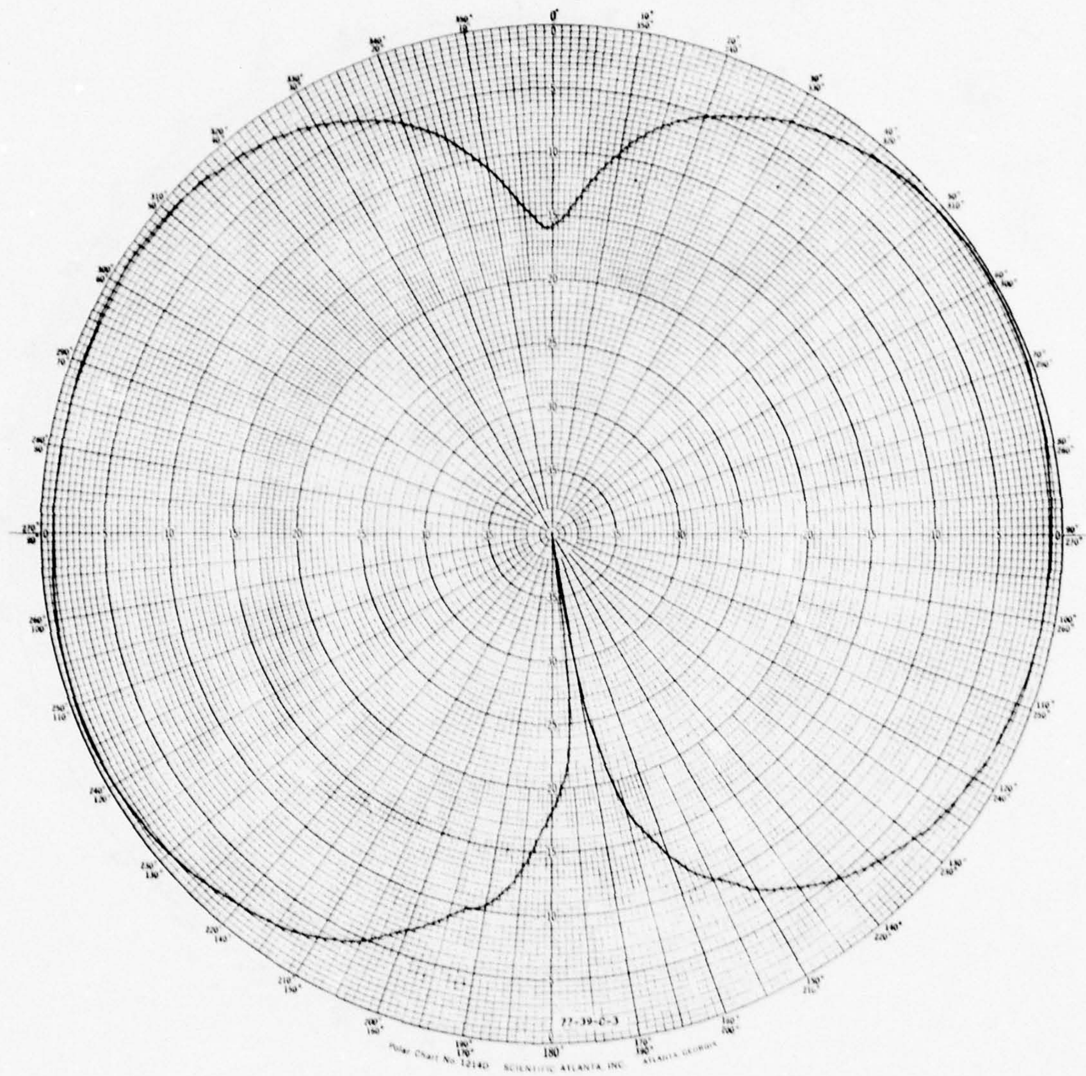


FIGURE C-3. FA-5675 VERTICAL RADIATION PATTERN

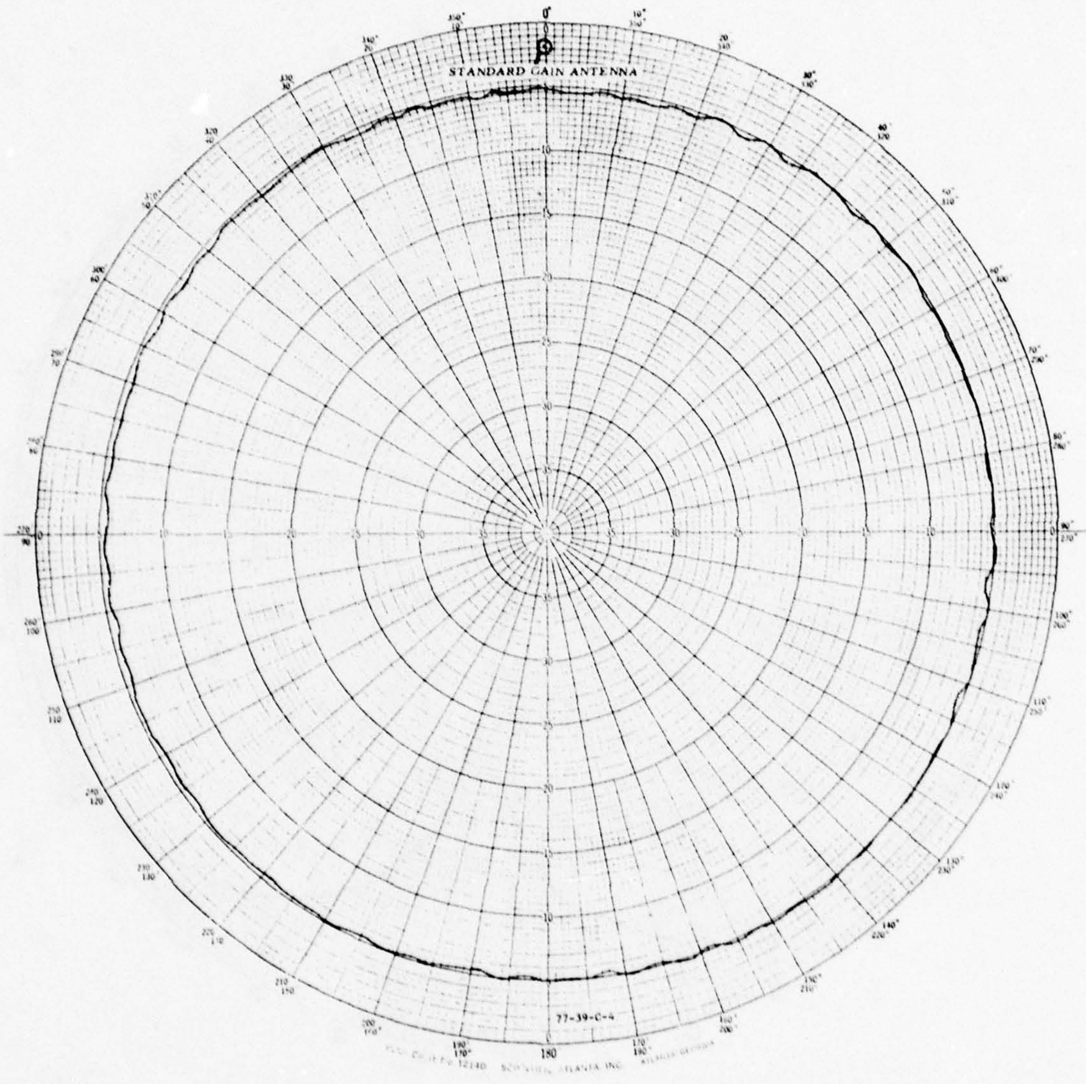


FIGURE C-4. FA-5675 HORIZONTAL RADIATION PATTERN

APPENDIX D

FA-5668 UHF DISCONE ANTENNA

The FA-5668 antenna shown in figure D-1 is a vertically polarized omnidirectional, broadband discone antenna that was designed to operate in the military air/ground communications frequency band of 225 to 400 MHz. This antenna was manufactured for the FAA by the Antenna Products Company, Mineral Wells, Texas, under contract FA65WA-1203. The FA-5668 antenna weighs 4 1/2 pounds, has overall dimensions of 15 3/8-inches high by 18 1/2-inches wide, and consists of a 12 5/8 inch diameter radiating disc and a lower hub assembly with six threaded element rods that are each 15 inches long. A glass reinforced plastic insulator separates the radiating disc from the cone section. This antenna is designed to mount on top of a mast having a maximum diameter of 1 3/4 inches.

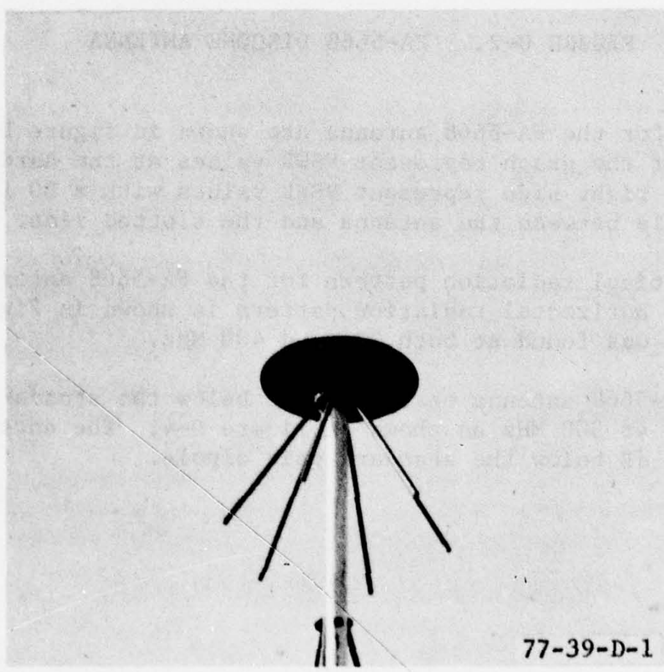
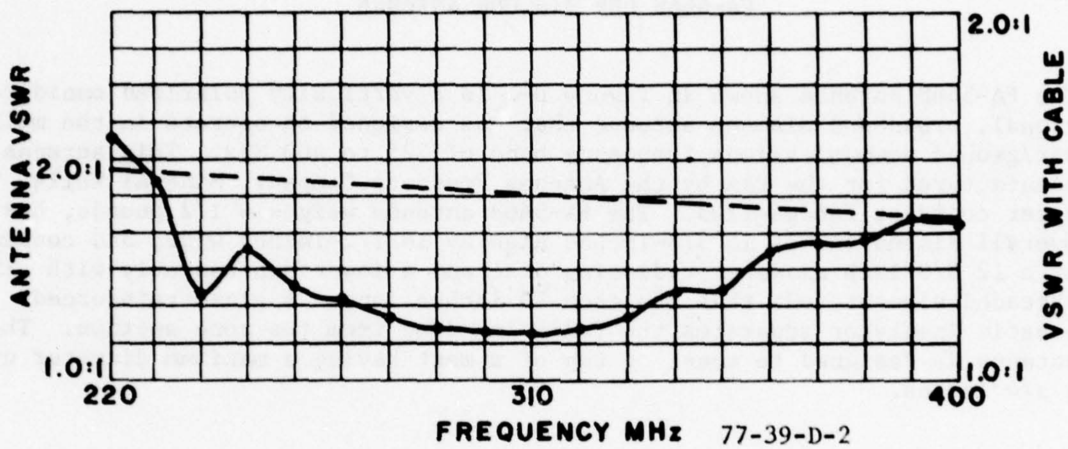


FIGURE D-1. FA-5668 UHF DISCONE ANTENNA



77-39-D-2

FIGURE D-2. FA-5668 DISCONE ANTENNA

VSWR measurements for the FA-5668 antenna are shown in figure D-2. The numbers on the left side of the graph represent VSWR values at the antenna terminals. The numbers on the right side represent VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

The free-space vertical radiation pattern for the FA-5668 antenna is shown in figure D-3 and the horizontal radiation pattern is shown in figure D-4. Some pattern distortion was found at both 225 and 400 MHz.

The gain of the FA-5668 antenna measured 1 dB below the standard gain dipole (-1 dBd or +1 dBi) at 300 MHz as shown in figure D-4. The antenna gain at 400 MHz measured 4 dB below the standard gain dipole.

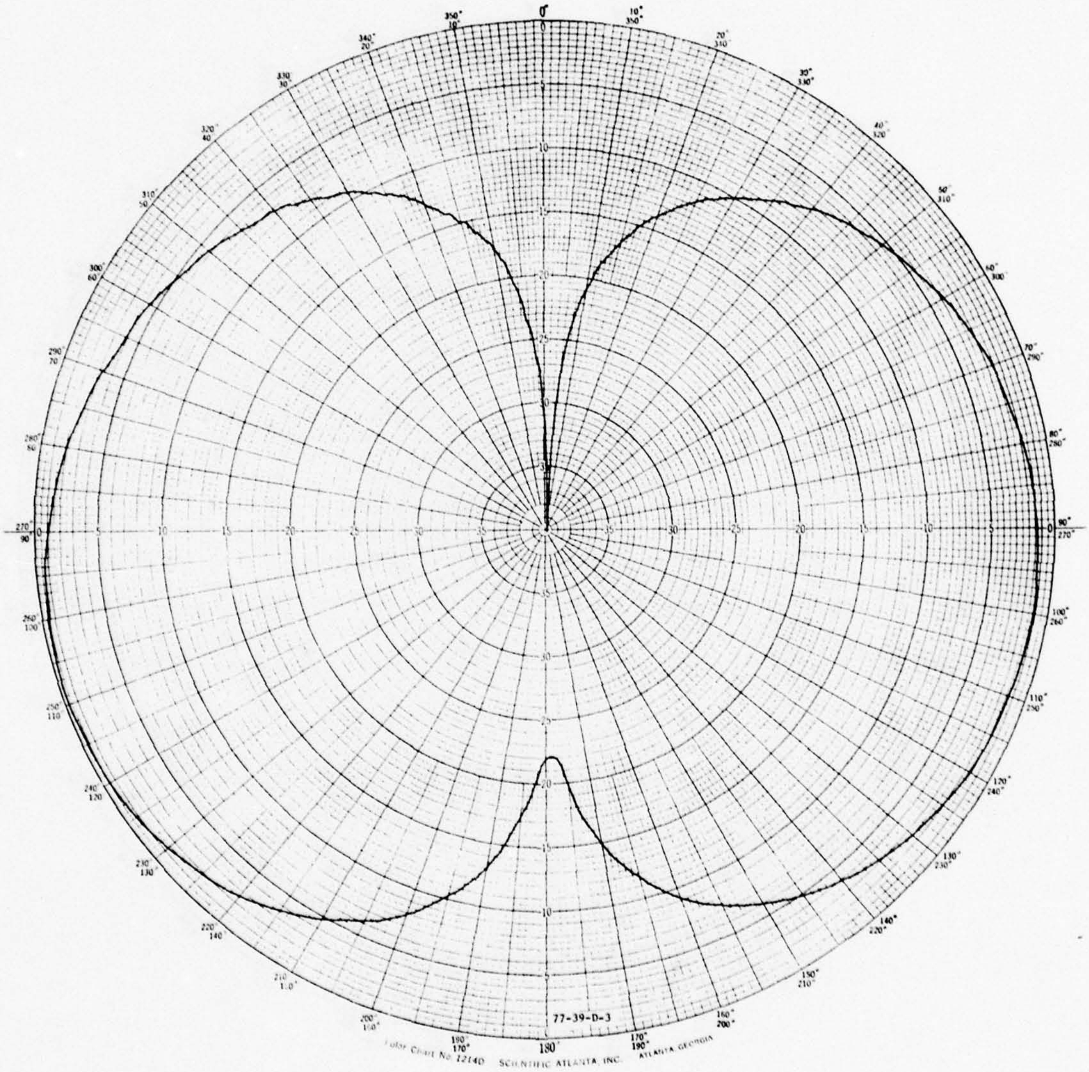


FIGURE D-3. FA-5668 VERTICAL RADIATION PATTERN

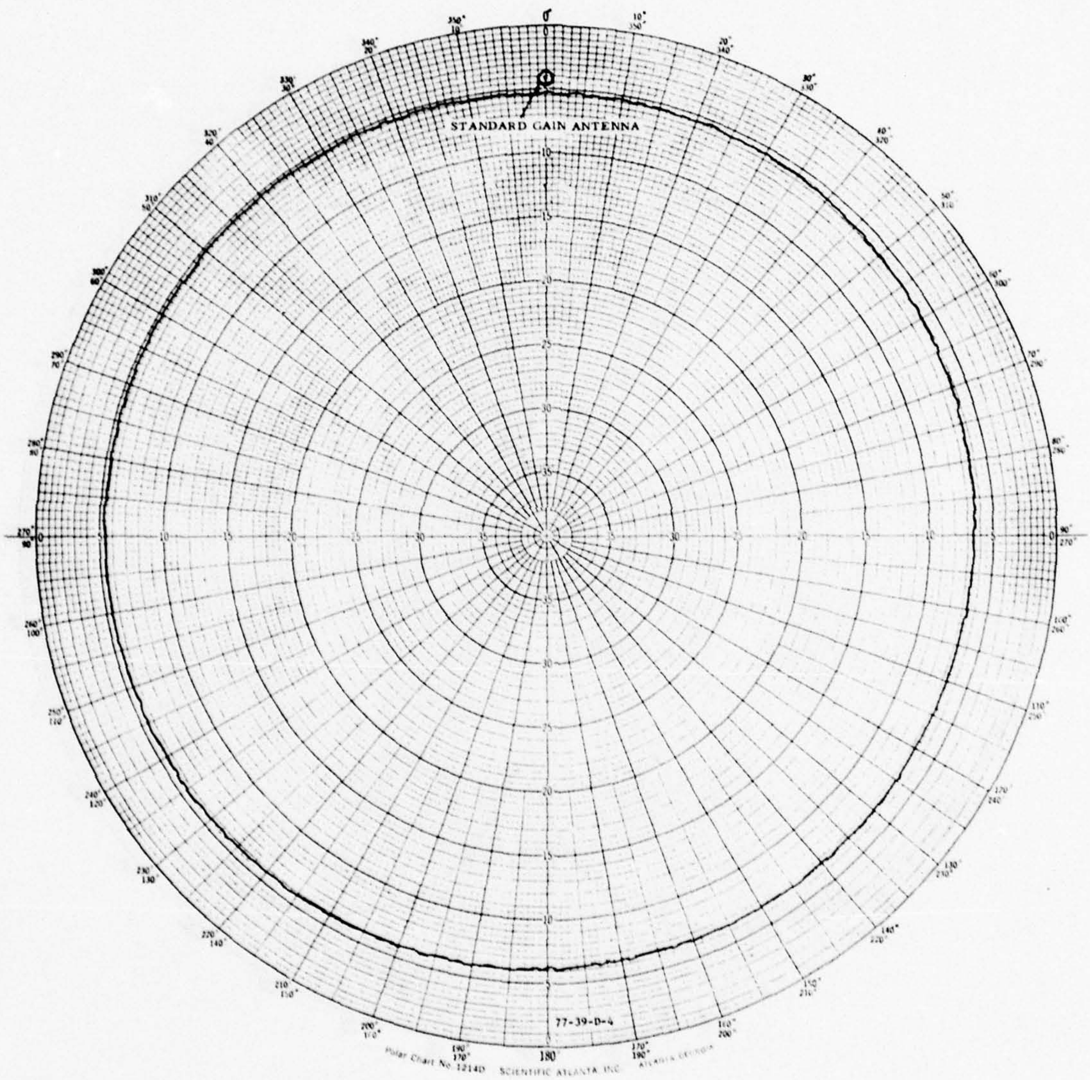


FIGURE D-4. FA-5668 HORIZONTAL RADIATION PATTERN

APPENDIX E

ANTENNA PRODUCTS DPV-22 UHF GAIN ANTENNA

The DPV-22 antenna shown in figure E-1 is a vertically polarized, omnidirectional broadband gain antenna that was designed to operate in the military A/G communications frequency band of 225 to 400 MHz. This antenna is the same as FAA types FA-7881A and FA-7881B per specification FAA-E-2277a that were manufactured under contracts DOT-FA72WA-3084 and DOT-FA76WA-3763. The DPV-22 antenna was manufactured by the Antenna Products Company, Mineral Wells, Texas, weighs 35 pounds, is 13 feet long by 4 1/2-inches in diameter, and cost $1,500.00.

The DPV-22 antenna consists of five stacked dipoles connected by a phasing harness which tilts the beam upwards. The antenna assembly is enclosed in a fiberglass housing which has permanently embedded deicing wires. The mounting bracket at the base of the antenna has two holes, 20 inches center to center to permit mounting with the use of 1/2 inch through bolts or lag screws.

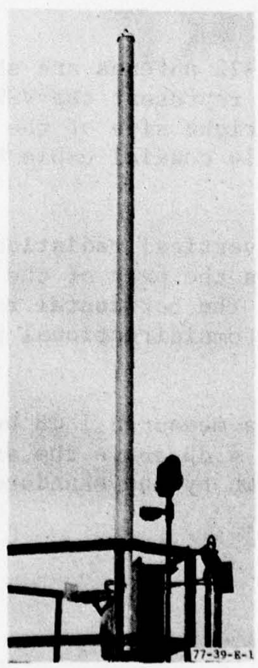


FIGURE E-1. DPV-22 UHF GAIN ANTENNA

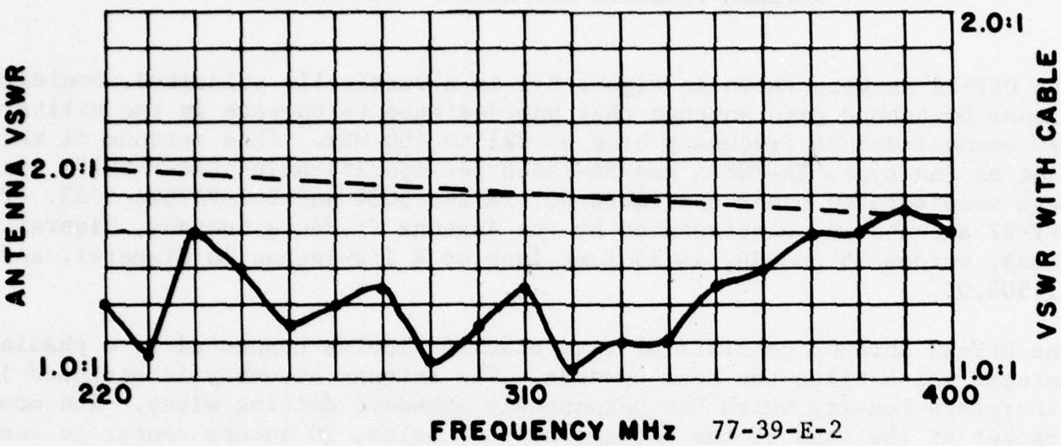


FIGURE E-2. DPV-22 GAIN ANTENNA

VSWR measurements for the DPV-22 antenna are shown in figure E-2. The numbers on the left side of the graph represent the VSWR values at the antenna terminal and the numbers at the right side of the graph represent the VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

Figure E-3 is the free-space vertical radiation pattern for the DPV-22 antenna at 300 MHz which shows the peak of the main beam to have a 8° upward tilt and a beamwidth of 14°. The horizontal radiation pattern in figure E-4 shows a 2 dB variation in the omnidirectional pattern strength measured on the horizon below the main beam.

The gain of the DPV-22 antenna measured 1 dB below the standard gain dipole at 300 MHz on the horizon and 4 dB above the standard gain dipole at the peak of the main beam, as shown by the standard gain antenna dots on the radiation patterns.

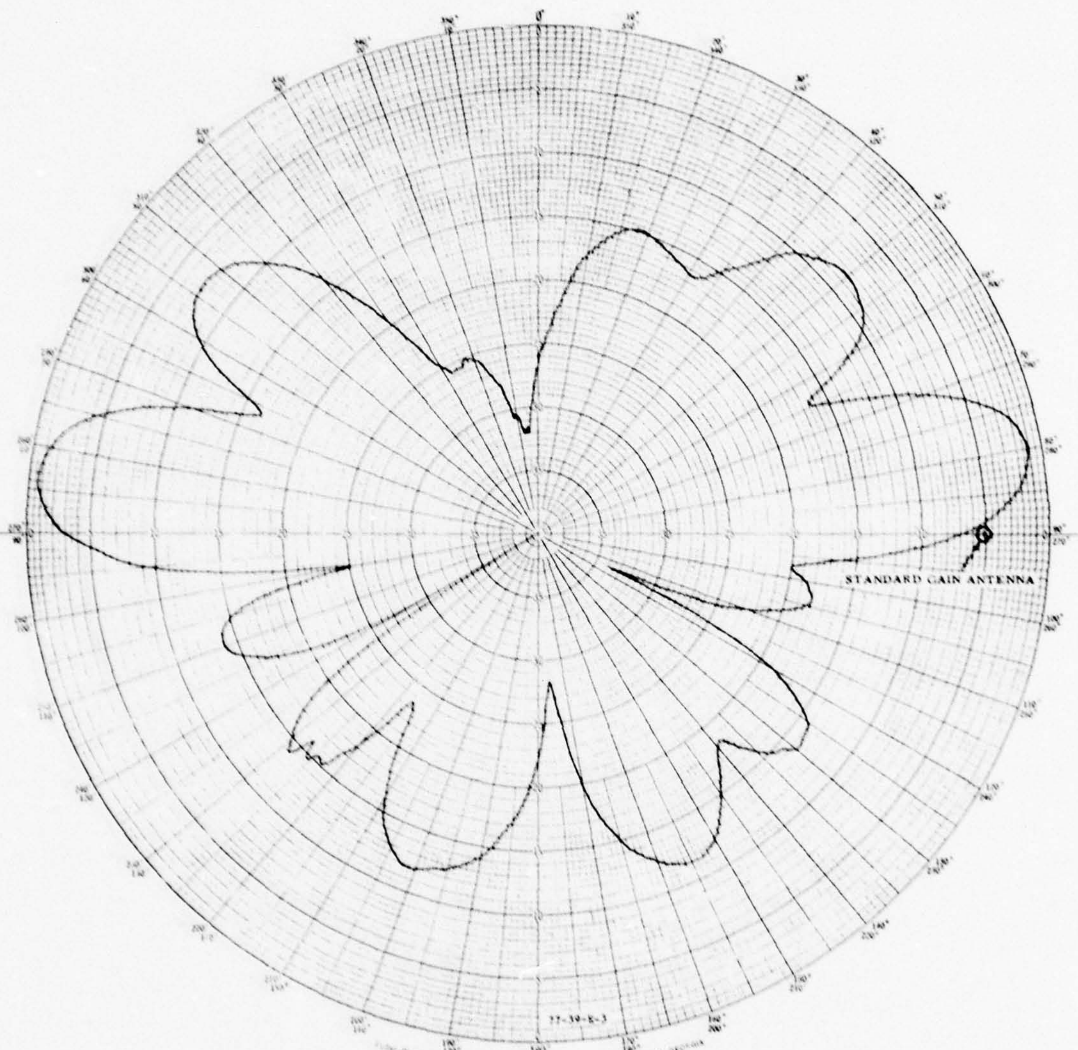


FIGURE E-3. DPV-22 VERTICAL RADIATION PATTERN

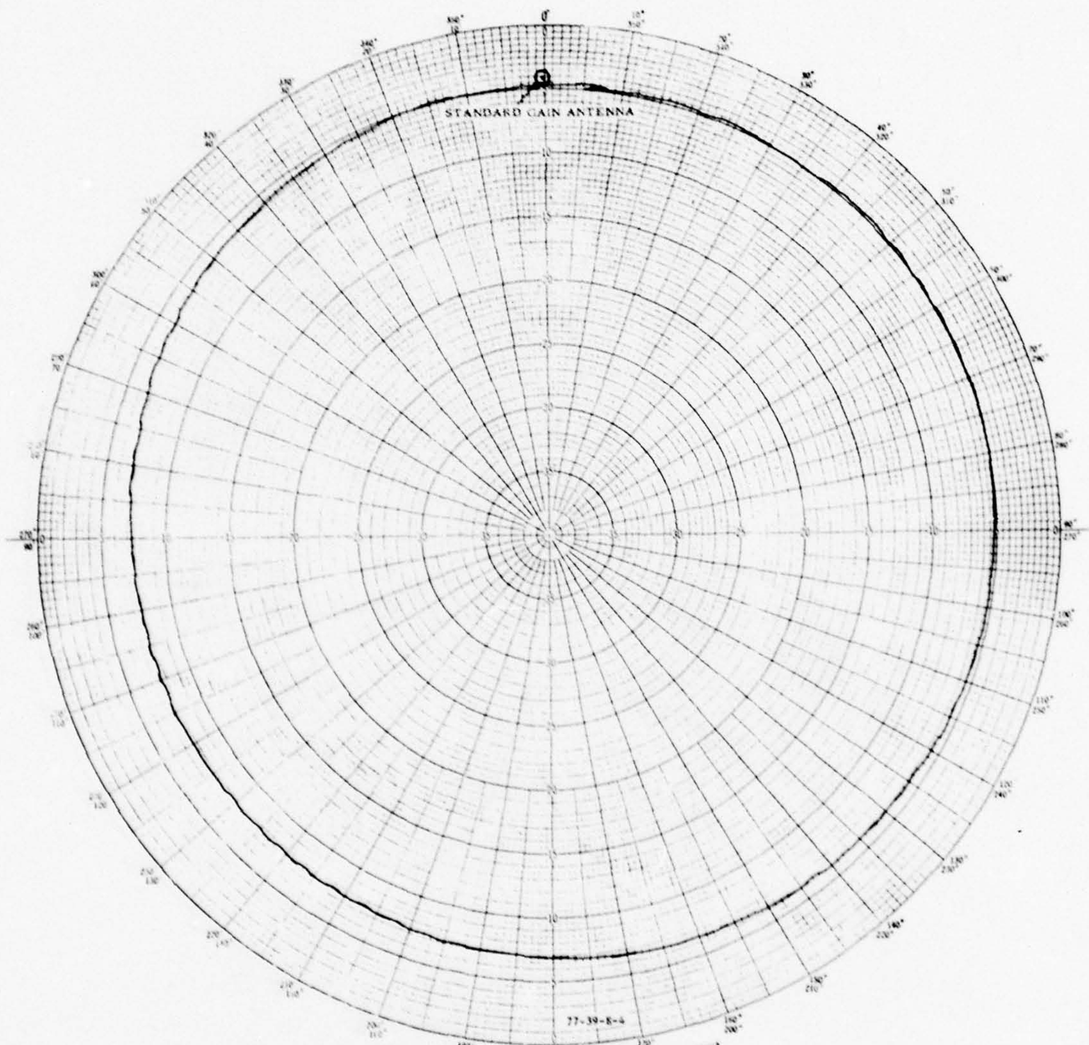


FIGURE E-4. DPV-22 HORIZONTAL RADIATION PATTERN

APPENDIX F

COLLINS 437B-7 UHF GAIN ANTENNA

The 437B-7 UHF antenna shown in figure F-1 is a vertically polarized omni-directional broadband gain antenna that was designed to operate in the military A/G communications frequency band of 225 to 400 MHz. This antenna was manufactured by the Collins Radio Group of Rockwell International, Dallas, Texas, and weighs 50 pounds, is 5 feet, 9 inches long by 8 inches in diameter, and cost $1.970.00.

This antenna is designed to be vertically stacked, up to four units high, supported only by the lower base flange, and be able to withstand 100 mile per hour winds with 1 inch of radial ice. The antenna consists of two collinearly arrayed radiating elements mounted concentrically around a common central aluminum tube, and foamed in place inside a fiberglass housing. An infinite bandwidth balun is used to provide equal power and equal phase to both dipoles across the band. A 1 1/2-inch diameter tube through the center of the antenna permits cables from other antennas to be brought through the center. The 11 1/2 inch diameter base flange is designed to mount to a support bracket with six 1/2-inch bolts.

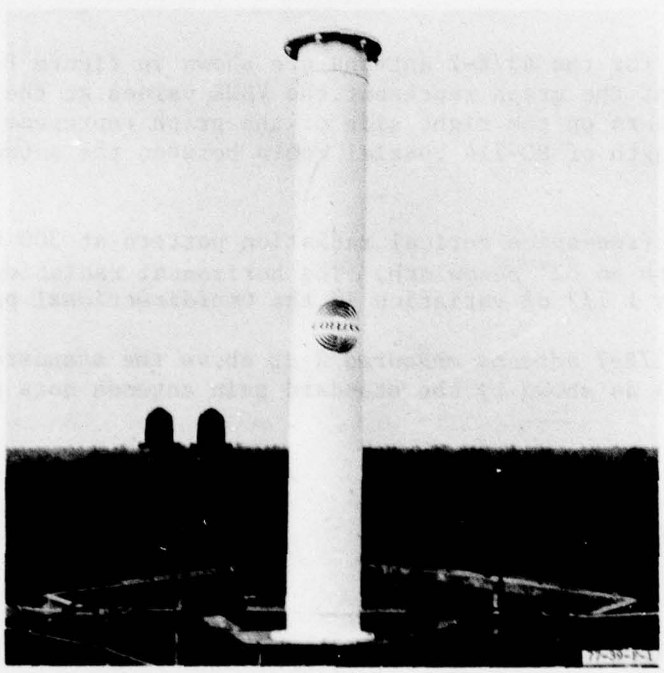


FIGURE F-1. 437B-7 UHF GAIN ANTENNA

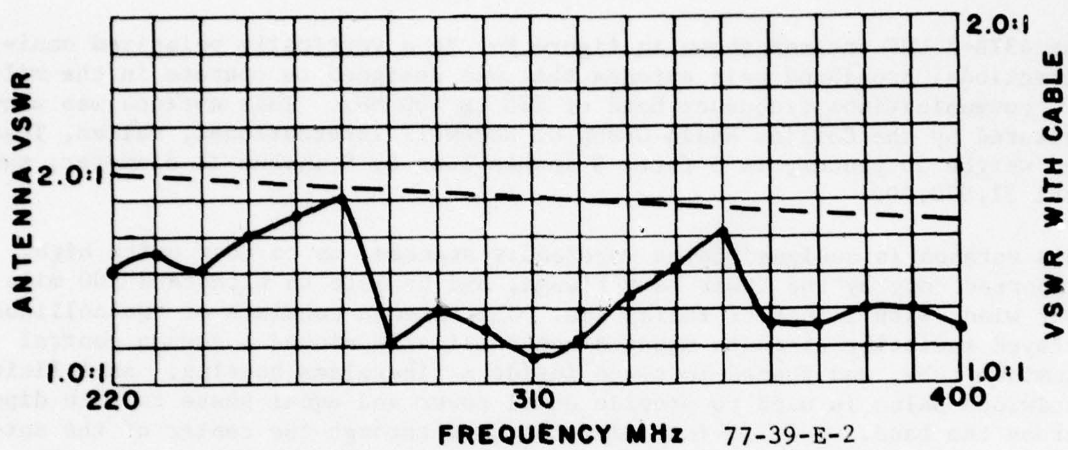


FIGURE F-2. COLLINS 437B-7 ANTENNA

VSWR measurements for the 437B-7 antenna are shown in figure F-2. The numbers on the left side of the graph represent the VSWR values at the antenna terminal and the numbers on the right side of the graph represent the VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

Figure F-3 is the free-space verical radiation pattern at 300 MHz which shows an upward tilt with an 82° beamwidth. The horizontal radiation pattern in figure F-4 shows a 1 1/2 dB variation in the omnidirectional pattern strength.

The gain of the 437B-7 antenna measured 2 dB above the standard gain dipole (+2 dBd or +4 dBi) as shown by the standard gain antenna dots on the radiation patterns.

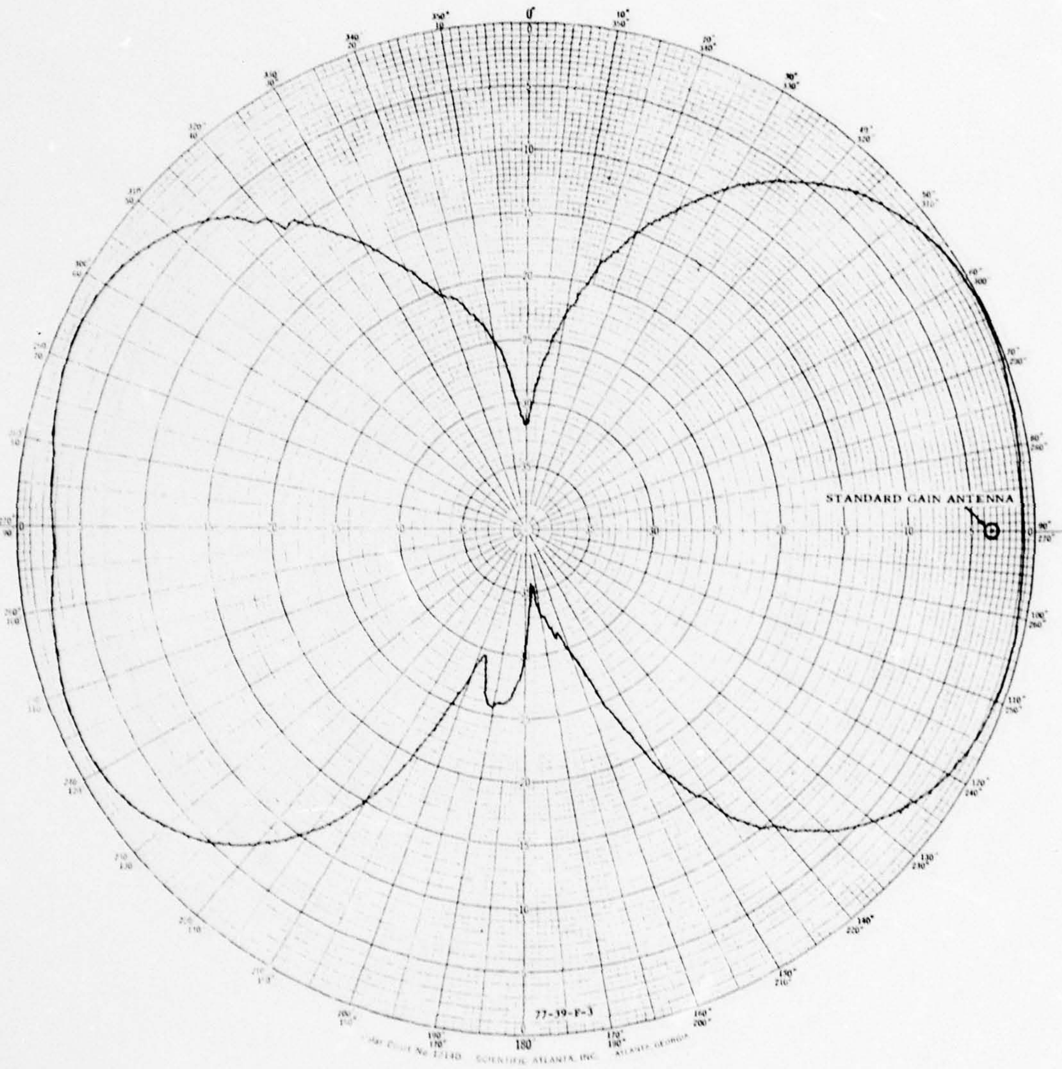


FIGURE F-3. 437B-7 VERTICAL RADIATION PATTERN

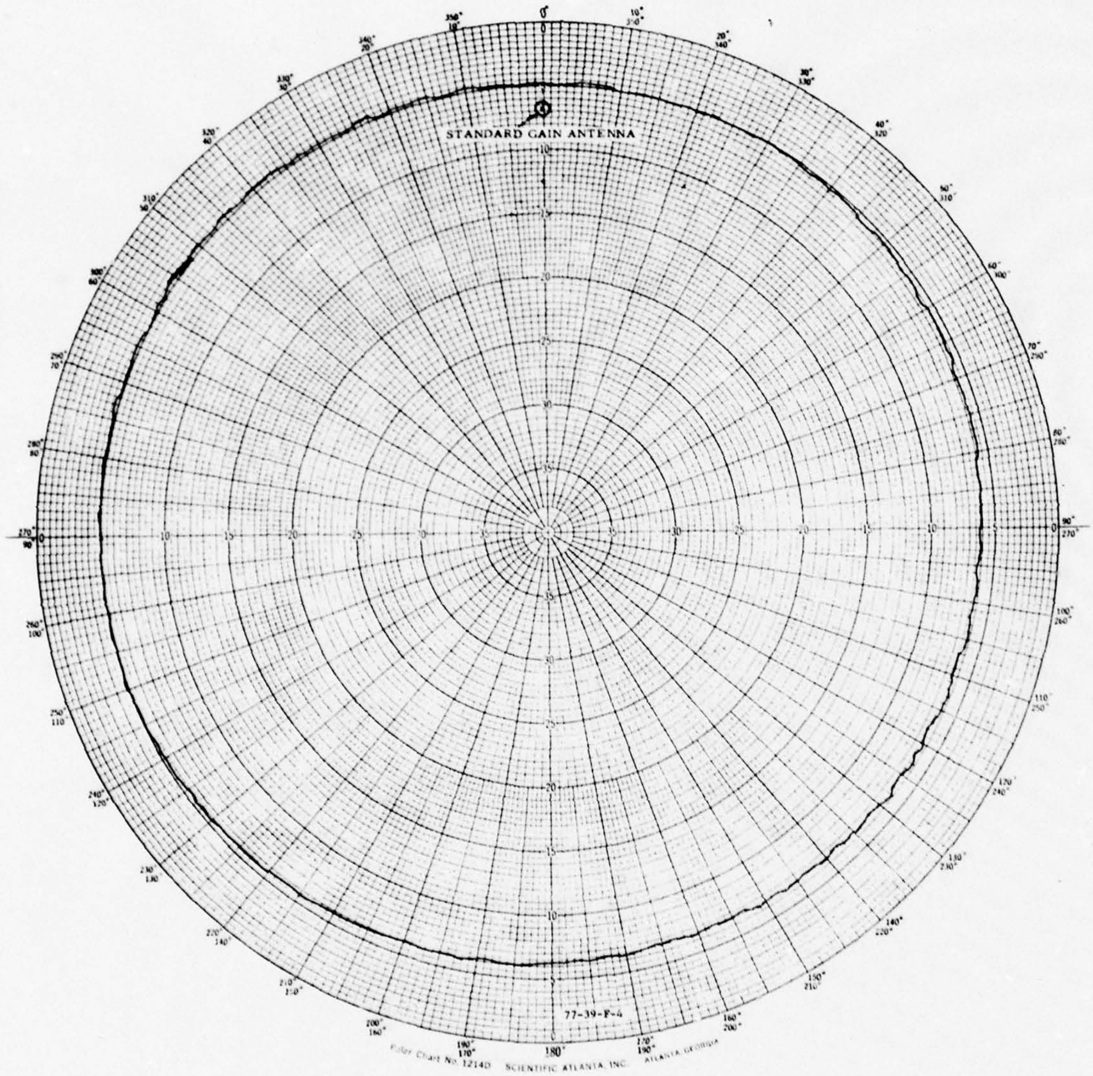


FIGURE F-4.   437B-7 HORIZONTAL RADIATION PATTERN

APPENDIX G

DECIBEL PRODUCTS DB-224 VHF GAIN ANTENNA

The DB-224 antenna shown in figure G-1 is a vertically polarized omnidirectional or directional gain antenna that was designed to operate with a center frequency of 127 MHz. This antenna was manufactured by Decibel Products, Inc., Dallas, Texas, weighs 35 pounds, is 23 feet 9 inches long, and cost $230.00. Due to its size, the DB-224 antenna was shipped to NAFEC in two 12-foot sections for ease of handling with each section consisting of two folded dipole elements and a cable harness. An omnidirectional radiation pattern is obtained with this antenna when all four dipole elements are evenly spaced every 90° around the mast. When all four dipoles are aligned on one side of the mast this antenna has directional characteristics and is designated as a DB-224E antenna.

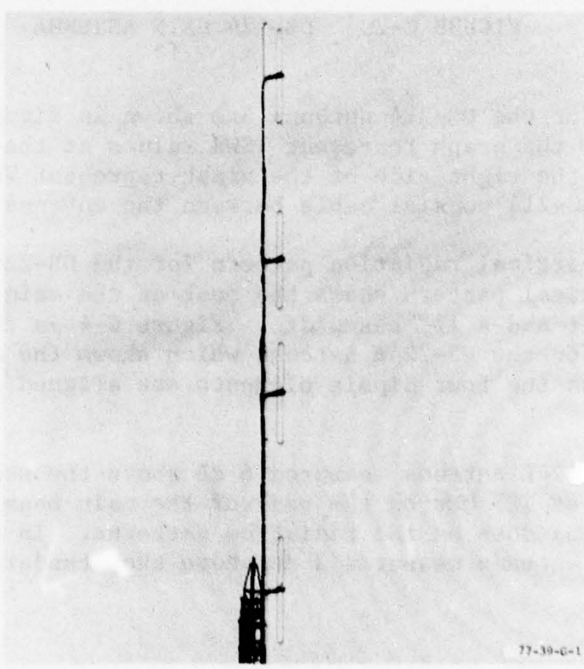


FIGURE G-1. DB-224 VHF GAIN ANTENNA

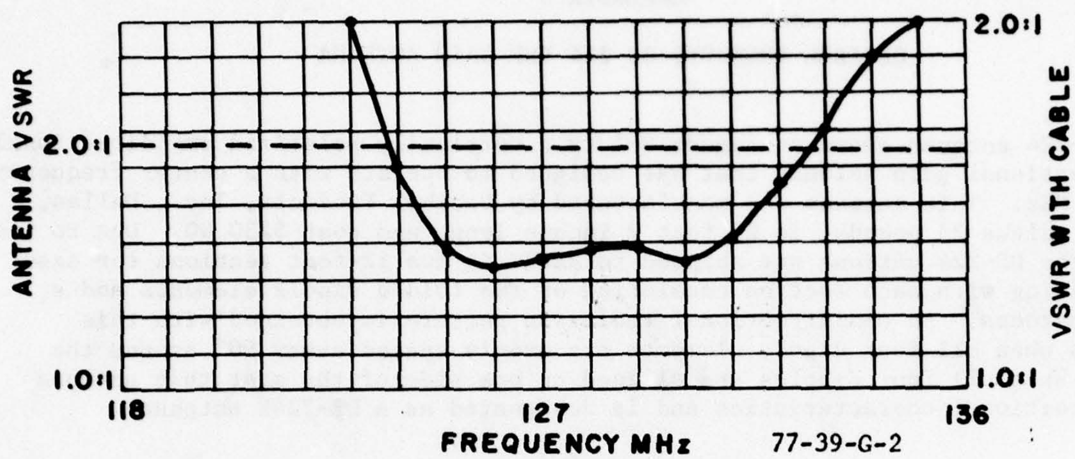


FIGURE G-2. DB-224 GAIN ANTENNA

VSWR measurements for the DB-224 antenna are shown in figure G-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

Figure G-3 is the vertical radiation pattern for the DB-224E antenna at 127 MHz. This vertical pattern shows the peak of the main beam to have a slight downward tilt and a 17° beamwidth. Figure G-4 is the horizontal radiation pattern for the DB-224E antenna which shows the offset directional characteristics when the four dipole elements are aligned on one side of the mast.

The gain of the DB-224E antenna measured 6 dB above the standard gain antenna (+6 dBd or +8 dBi) at 127 MHz on the peak of the main beam, as shown by the standard gain antenna dots on the radiation patterns. In the omnidirectional configuration, the antenna measured 3 dB above the standard gain dipole.

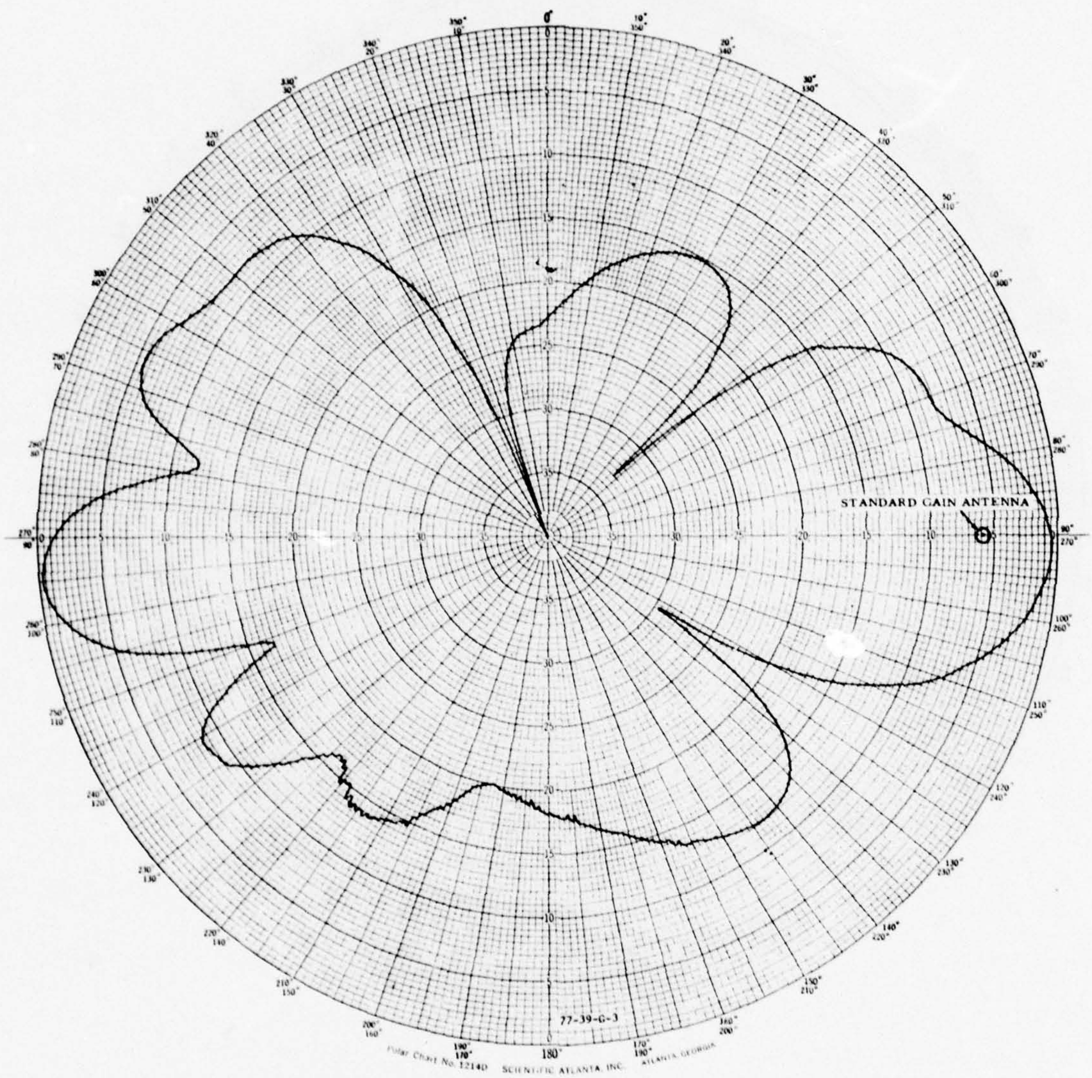


FIGURE G-3. DB-224E VERTICAL RADIATION PATTERN

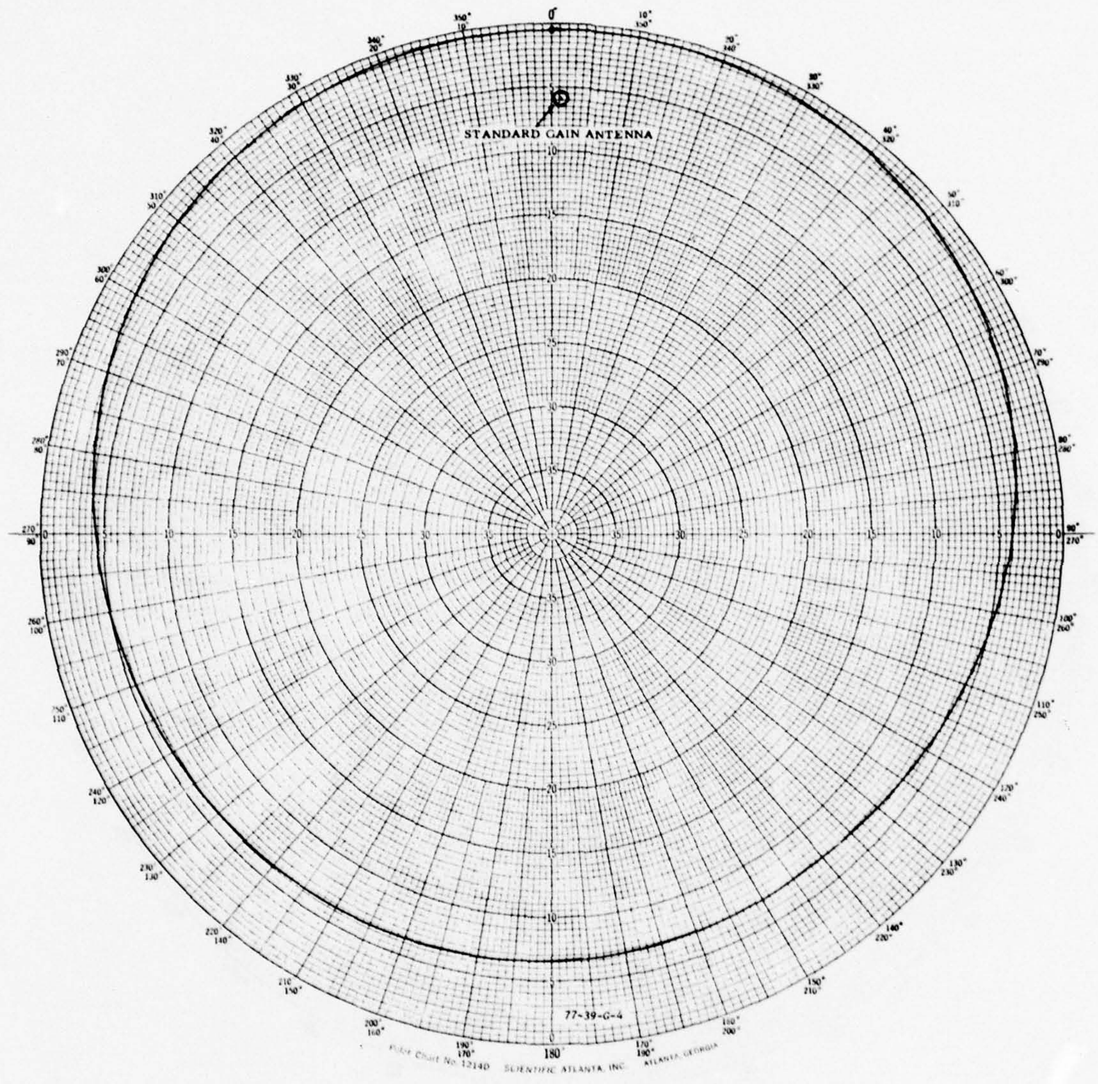


FIGURE G-4. DB-224E HORIZONTAL RADIATION PATTERN

APPENDIX H

DB PRODUCTS DB-230 VHF DIRECTIONAL YAGI ANTENNA

The DB-230 antenna shown in figure H-1 is a vertically polarized, directional YAGI antenna that was designed to operate with a center frequency of 127 MHz. This three-element YAGI antenna was manufactured by Decibel Products, Inc., Dallas, Texas, and weighs 6 1/2 pounds, is 51 inches long, 46 1/2 inches high, costs \$128.00, and consists of a 40-inch director, a 43 7/8-inch radiator, and a 46 1/2-inch reflector, spaced 19 3/4 inches apart on a 51-inch support boom. A 1 3/4-inch aluminum angle welded to the support boom is used to mount this antenna to a support pipe.

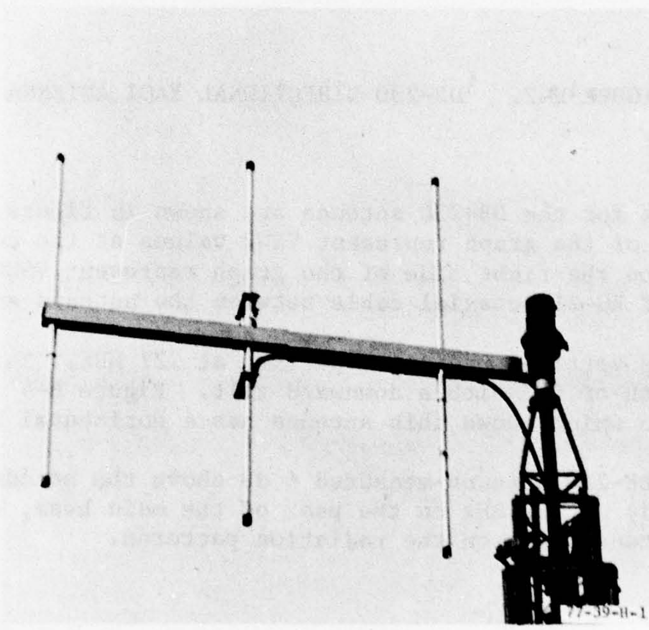


FIGURE H-1. DB-230 DIRECTIONAL YAGI ANTENNA

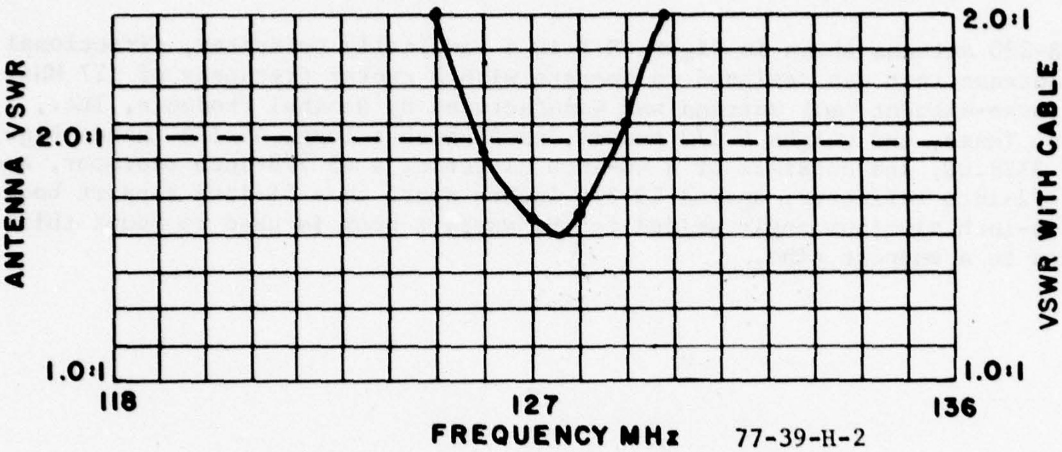


FIGURE H-2. DB-230 DIRECTIONAL YAGI ANTENNA

VSWR measurements for the DB-230 antenna are shown in figure H-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

Figure H-3 is the vertical radiation pattern at 127 MHz. This pattern shows a vertical beamwidth of 60° with a downward tilt. Figure H-4 is the horizontal radiation pattern which shows this antenna has a horizontal beamwidth of 90°.

The gain of the DB-230 antenna measured 6 dB above the standard gain dipole (+6 dBd or +8 dBi) at 127 MHz on the peak of the main beam, as shown by the standard gain antenna dots on the radiation patterns.

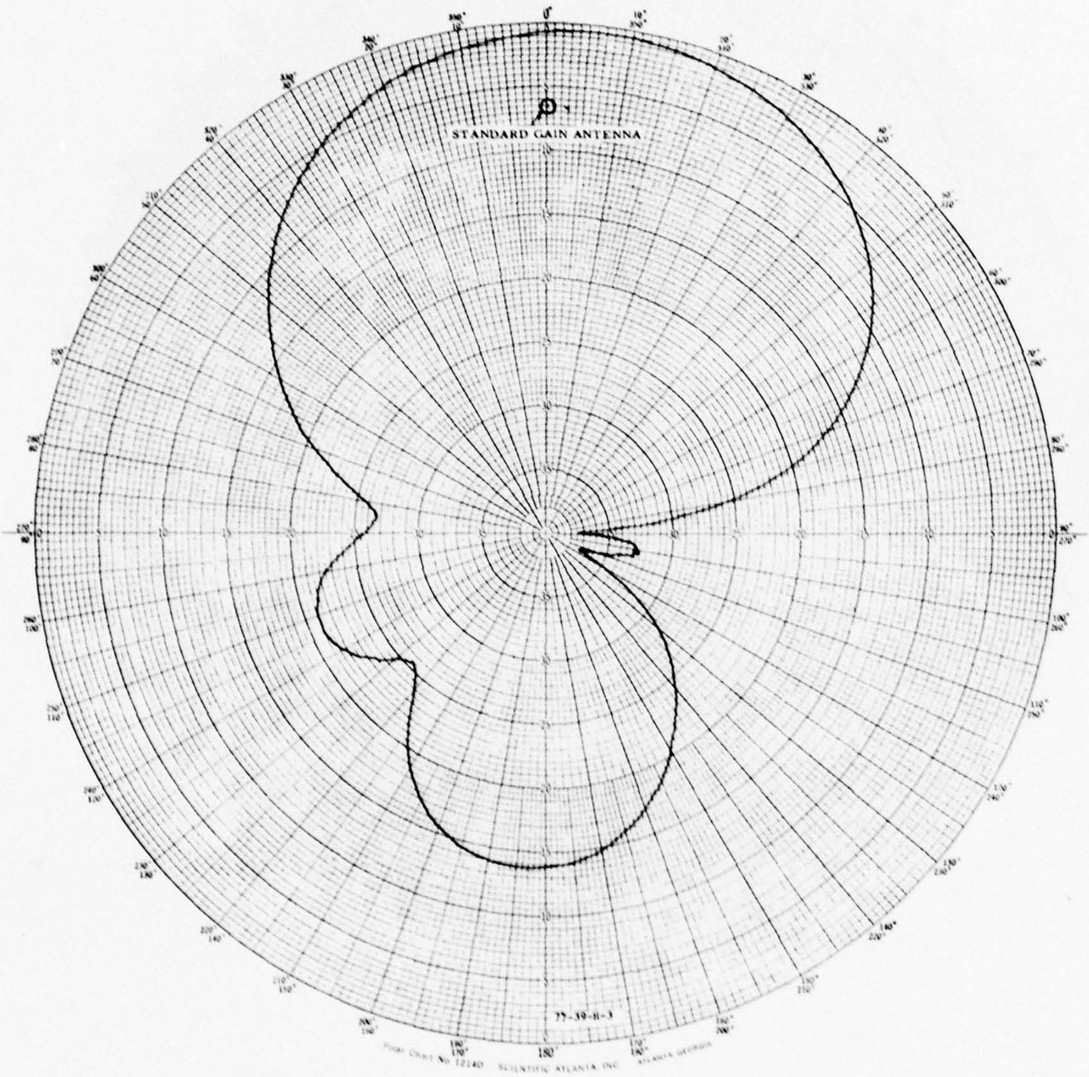


FIGURE H-3. DB-230 VERTICAL RADIATION PATTERN

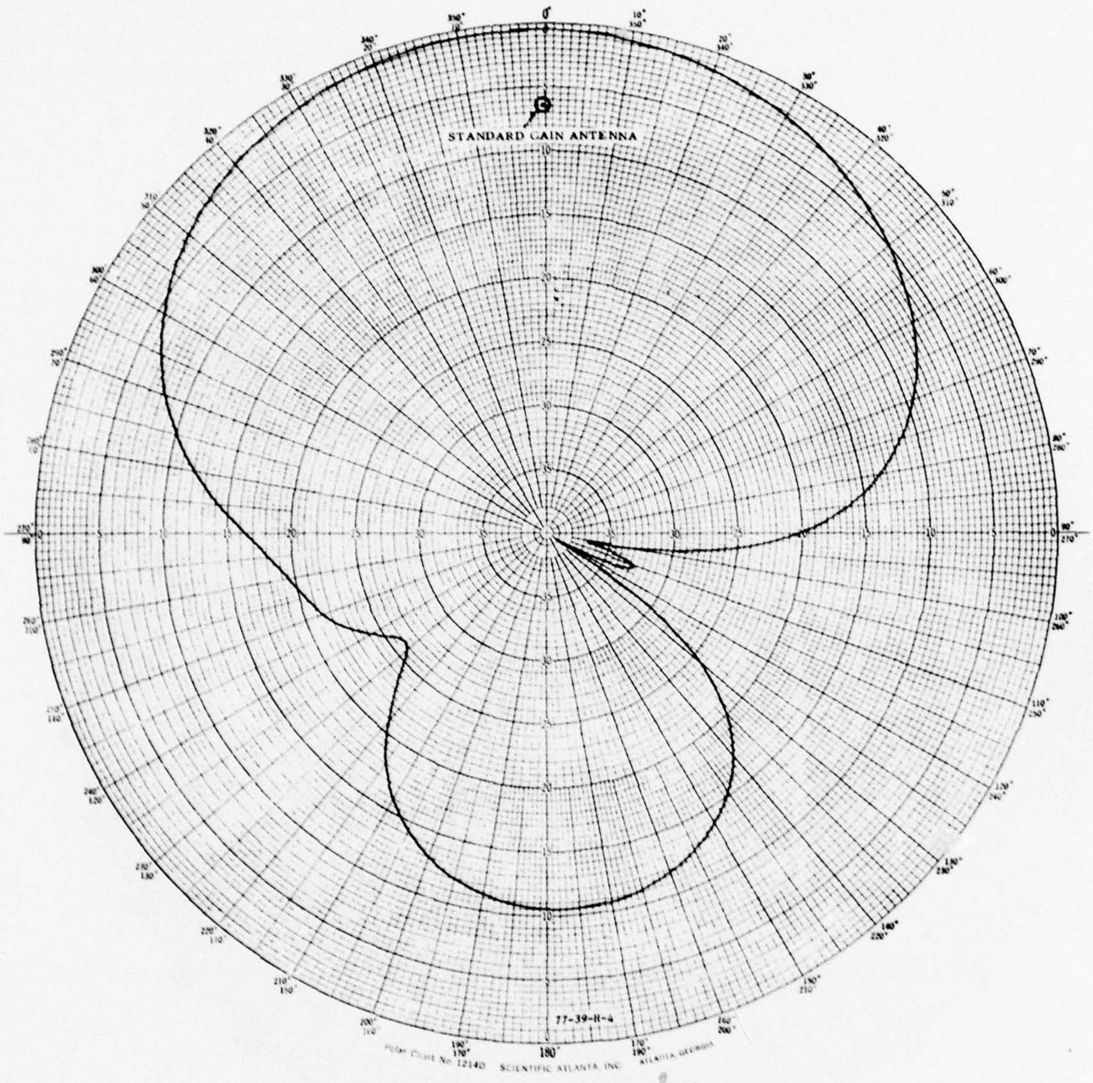


FIGURE H-4. DB-230 HORIZONTAL RADIATION PATTERN

APPENDIX I

DB PRODUCTS DB-286 VHF DIRECTIONAL YAGI ARRAY

The DB-286 antenna shown in figure I-1 is a vertically polarized, directional YAGI array that was designed to operate with a center frequency of 127 MHz. This antenna array was manufactured by Decibel Products, Inc., Dallas, Texas, and weighs 15 1/4 pounds, is 40-inches long by 40-inches wide by 46 1/2-inches high, cost $195.00 and consists of two 3-element yagis spaced 1/2 wavelength apart that are fed in phase through a quarter wave transformer. Each 3-element YAGI contains a 46 1/2-inch long reflector, a 44-inch radiator, and a 40 1/2-inch director that are spaced 19 inches apart on a 39 1/2-inch support boom. A 1 3/4-inch aluminum angle is welded to the 36-inch crossboom to permit the mounting of this antenna array on a support pipe.

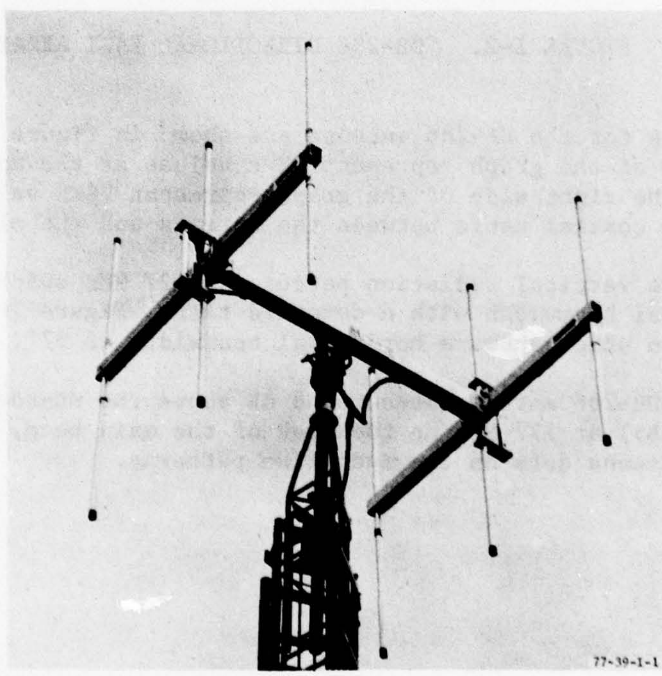


FIGURE I-1. DB-286 DIRECTIONAL YAGI ARRAY

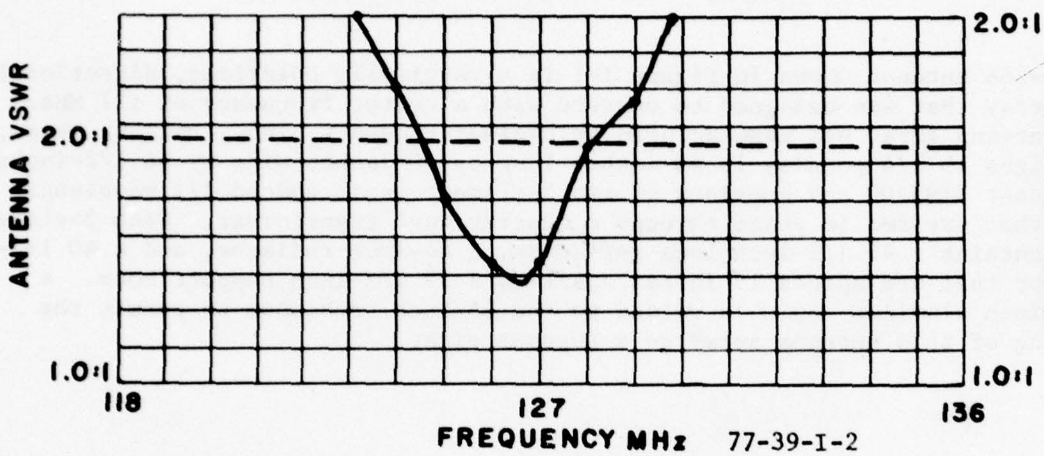


FIGURE I-2. DB-286 DIRECTIONAL YAGI ARRAY

VSWR measurements for the DB-286 antenna are shown in figure I-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

Figure I-3 is the vertical radiation pattern at 127 MHz which shows this antenna has a 51° vertical beamwidth with a downward tilt. Figure I-4 is the horizontal radiation pattern which shows a horizontal beamwidth of 57°.

The gain of the DB-286 antenna measured 8 dB above the standard gain dipole (+8 dBd or +10 dBi) at 127 MHz on the peak of the main beam, as shown by the standard gain antenna dots on the radiation patterns.

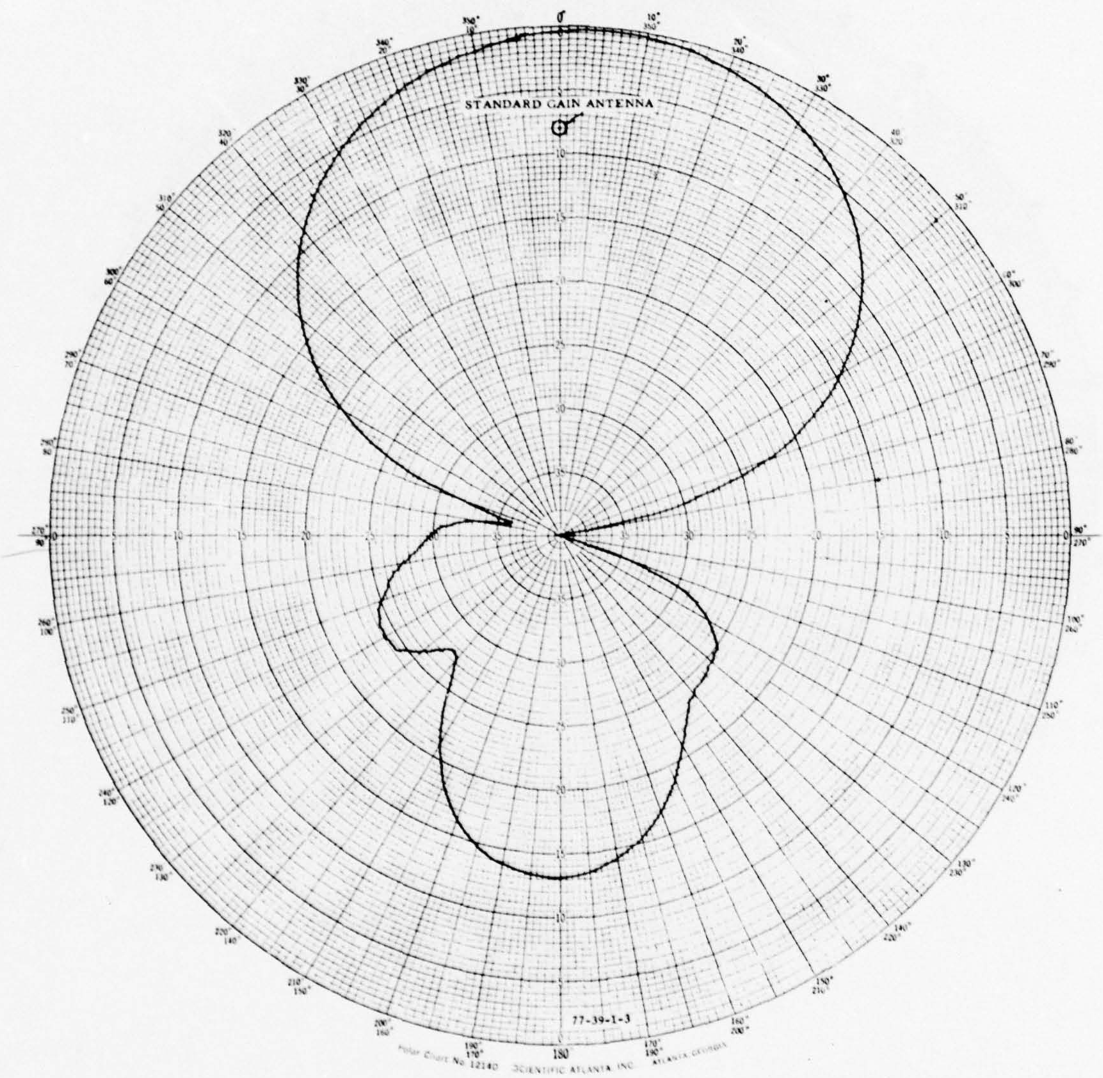


FIGURE I-3. DB-286 VERTICAL RADIATION PATTERN

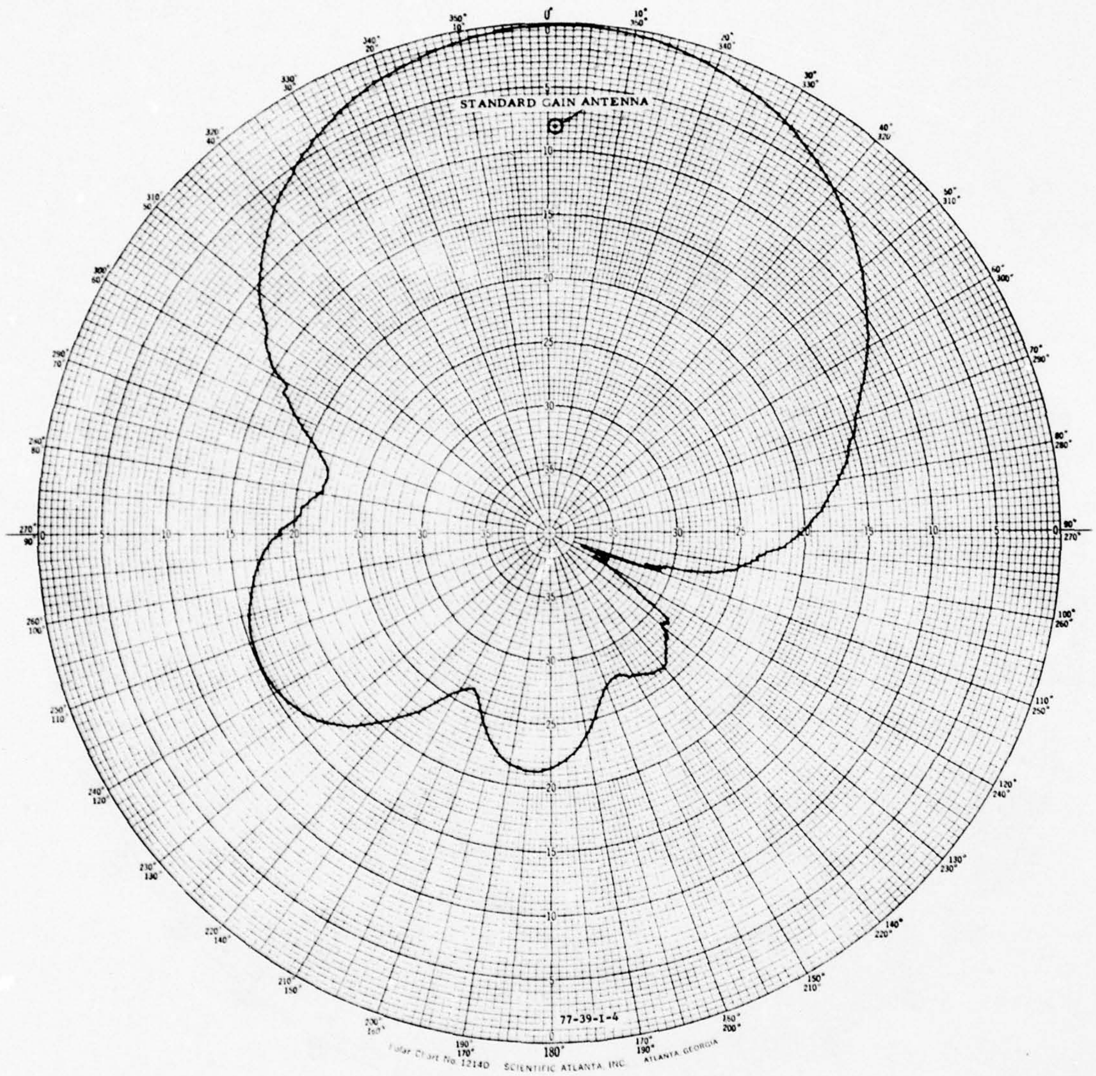


FIGURE I-4. DB-286 HORIZONTAL RADIATION PATTERN

APPENDIX J

KRECO SC-155BN MULTIPLE-SKIRT COAXIAL DIPOLE ANTENNA

The SC-155BN antenna shown in figure J-1 is a vertically polarized, omnidirectional, multiple-skirt coaxial dipole that was designed to operate with a center frequency of 127 MHz. This antenna was manufactured by the H. Kreckman Company, Cresco, Pennsylvania and costs $138.00. When the SC-155BN antenna elements were assembled on a government furnished 12-foot long, 1 1/4 inch thick wall aluminum pipe the antenna assembly weighed 27 pounds and was 14-foot long. The supplied antenna elements consisted of a 20 1/2-inch long radiating element, three 22 3/4-inch skirts, a glass insulator hub assembly and a ground-plane assembly. The glass insulator hub assembly has standard 1 1/4-inch pipe thread for mounting on a support pipe.

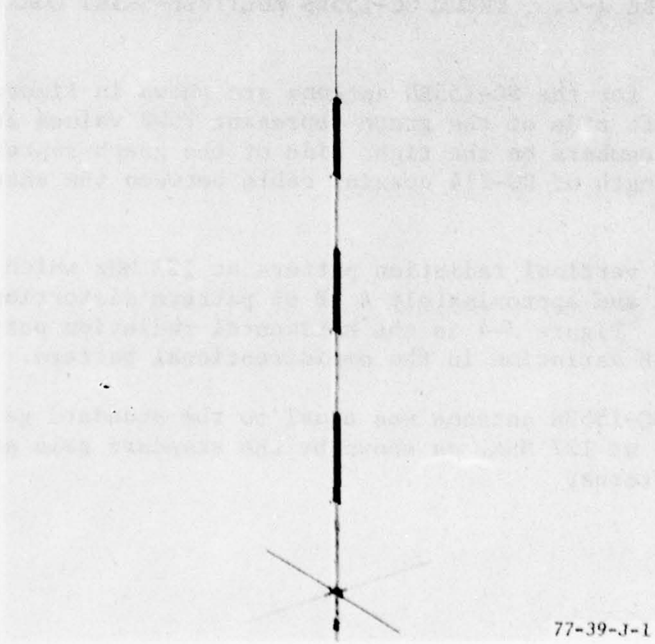


FIGURE J-1. SC-155BN MULTIPLE-SKIRT COAXIAL DIPOLE

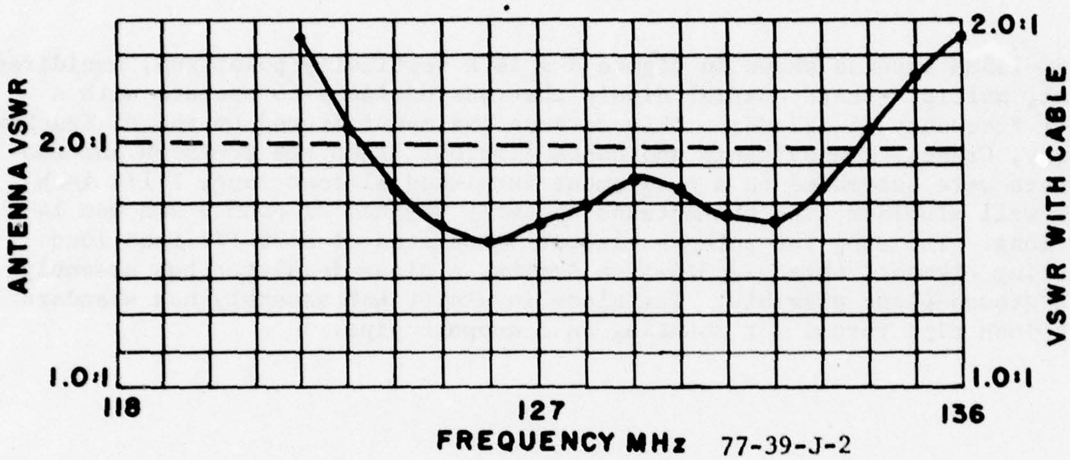


FIGURE J-2. KRECO SC-155BN MULTIPLE-SKIRT COAXIAL ANTENNA

VSWR measurements for the SC-155BN antenna are shown in figure J-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

Figure J-3 is the vertical radiation pattern at 127 MHz which shows a vertical beamwidth of 107° and approximately 4 dB of pattern distortion below the peak of the main beam. Figure J-4 is the horizontal radiation pattern which shows a less than 1/2 dB variation in the omnidirectional pattern.

The gain of the SC-155BN antenna was equal to the standard gain dipole (0 dBd or +2 dBi) at 127 MHz, as shown by the standard gain antenna dots on the radiation patterns.

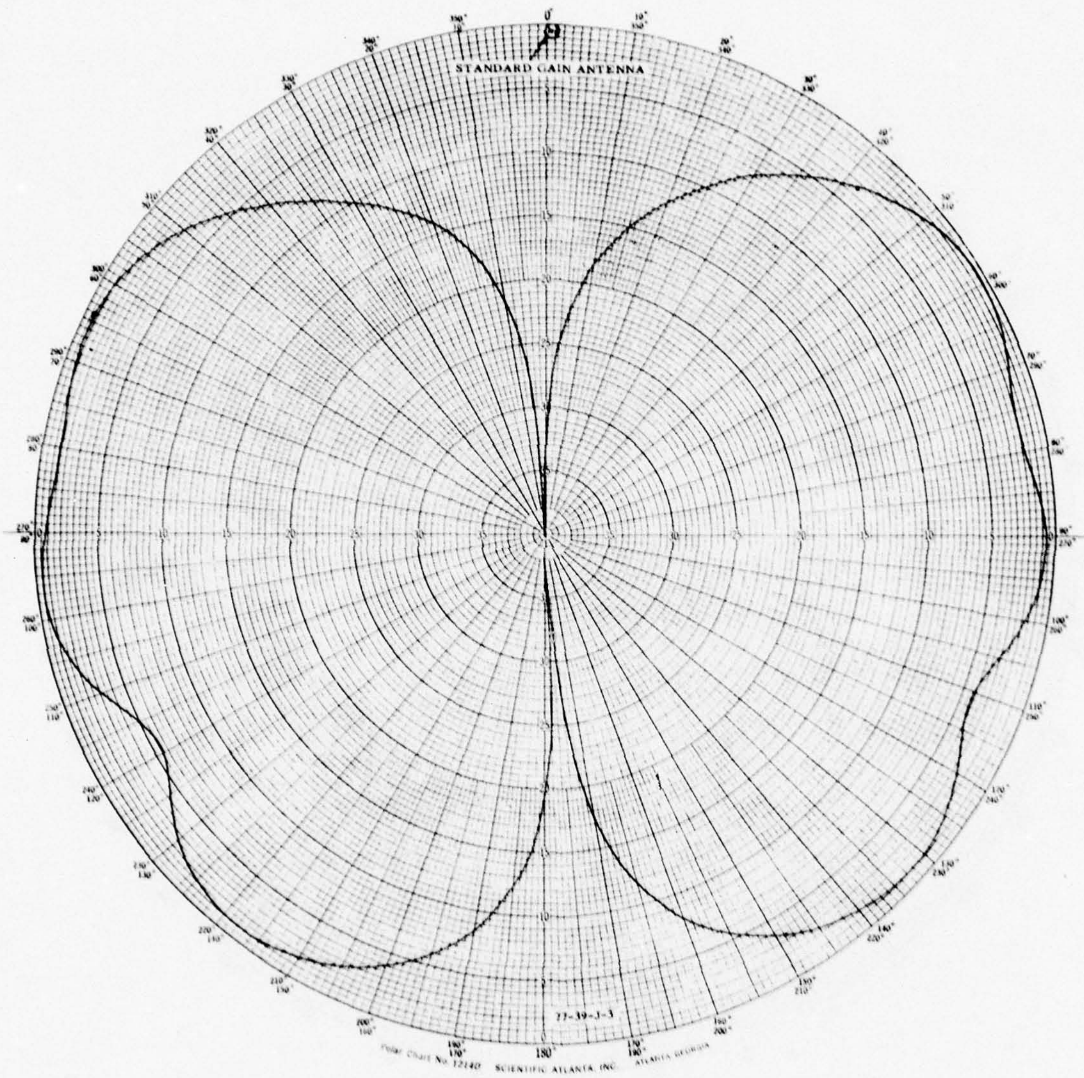


FIGURE J-3. SC-155BN VERTICAL RADIATION PATTERN

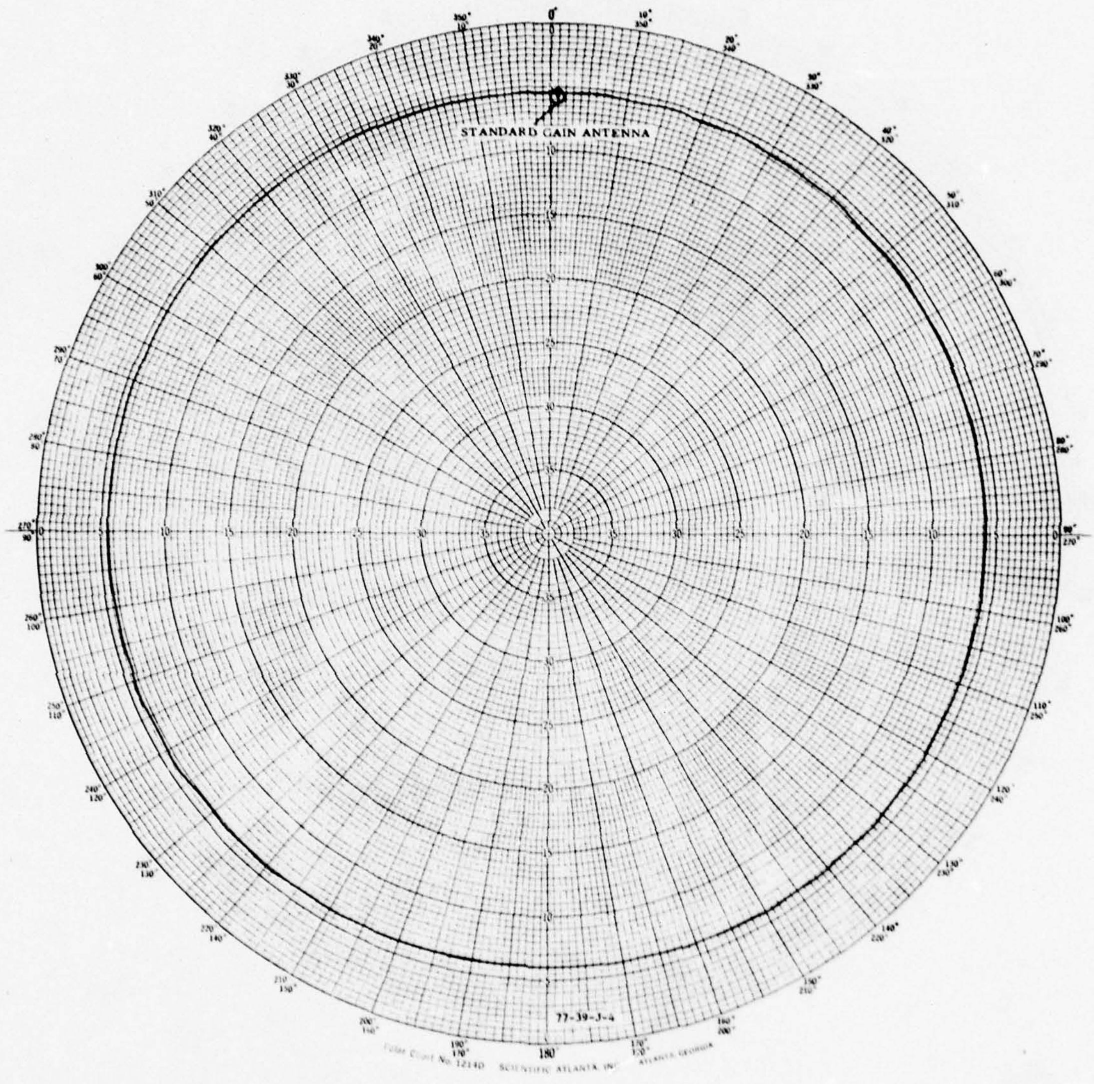


FIGURE J-4. SC-155BN HORIZONTAL RADIATION PATTERN

APPENDIX K

KRECO VB-155BN VHF DIRECTIONAL YAGI ANTENNA

The VB-155BN antenna shown in figure K-1 is a vertically polarized, three element, directional YAGI that was designed to operate with a center frequency of 127 MHz. This antenna was manufactured by the H. Kreckman Company, Cresco, Pennsylvania, and cost $112.00. When installed on a 5-foot aluminum pipe, the antenna weighs 16 pounds and consists of a 20 1/2-inch folded radiating element, a 23 1/2-inch skirt which is separated from the radiating element by a 2-inch glass insulator hub assembly, a 44-inch director assembly and a 48-inch reflector assembly. The folded radiating element provides a DC path to ground for protection against static build-up and lightning. The grounded side of the radiating element is smaller in diameter to obtain the correct impedance match. The director and reflector elements were spaced 11 inches from the radiating element. The antenna hub assembly mounts on a 1 1/4-inch support pipe with standard pipe thread on one end.

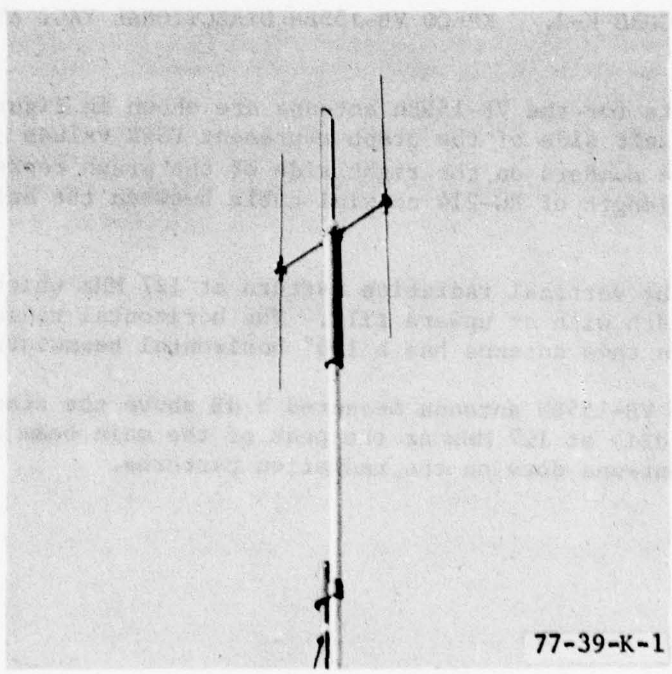


FIGURE K-1. VB-155BN DIRECTIONAL YAGI

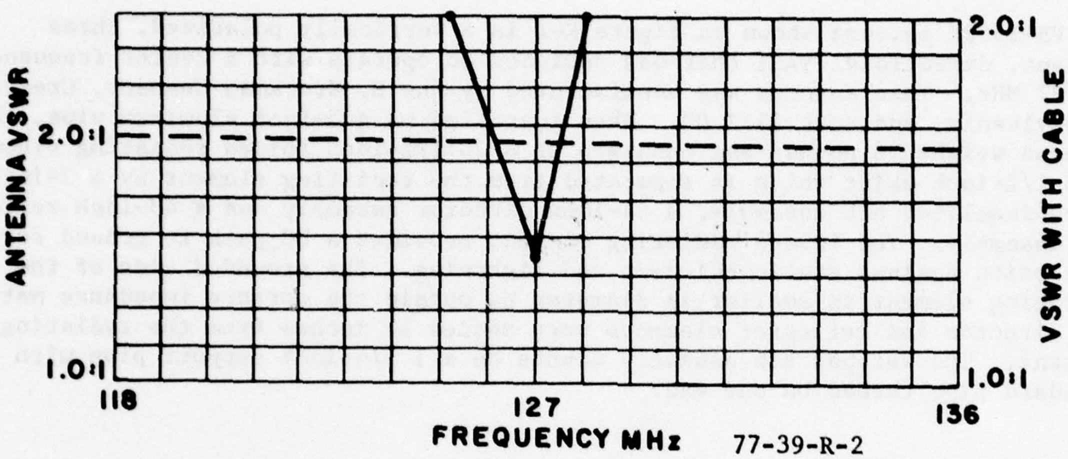


FIGURE K-2. KRECO VB-155BN DIRECTIONAL YAGI ANTENNA

VSWR measurements for the VB-155Bn antenna are shown in figure K-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represents VSWR values with a 50-foot length of RG-214 coaxial cable between the antenna and the slotted line.

Figure K-3 is the vertical radiation pattern at 127 MHz which shows a 60° vertical beamwidth with an upward tilt. The horizontal radiation pattern in figure K-4 shows this antenna has a 106° horizontal beamwidth.

The gain of the VB-155BN antenna measured 8 dB above the standard gain dipole (+8 dBd or +10 dBi) at 127 MHz at the peak of the main beam as shown by the standard gain antenna dots on the radiation patterns.

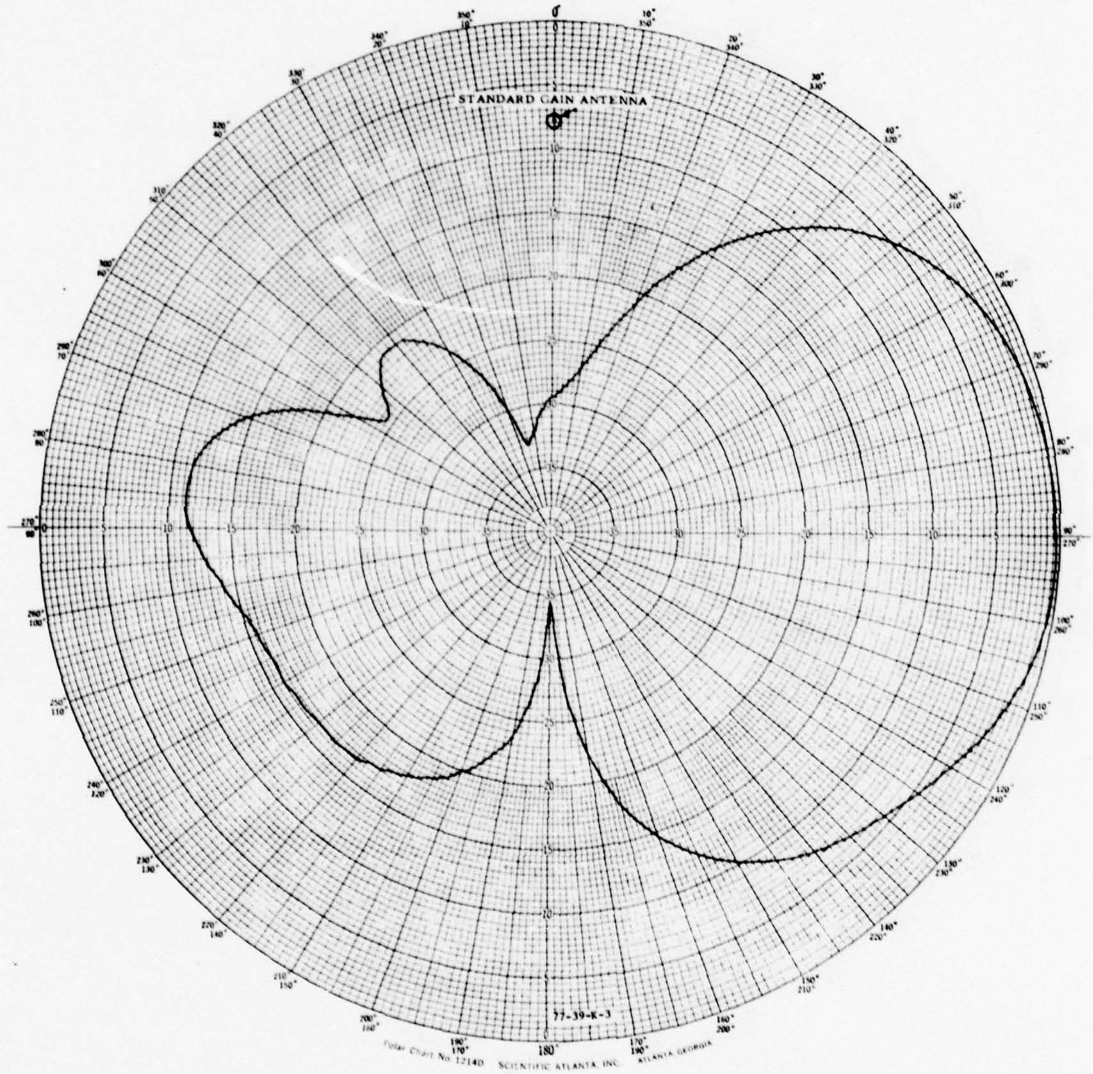


FIGURE K-3. VB-155 VERTICAL RADIATION PATTERN

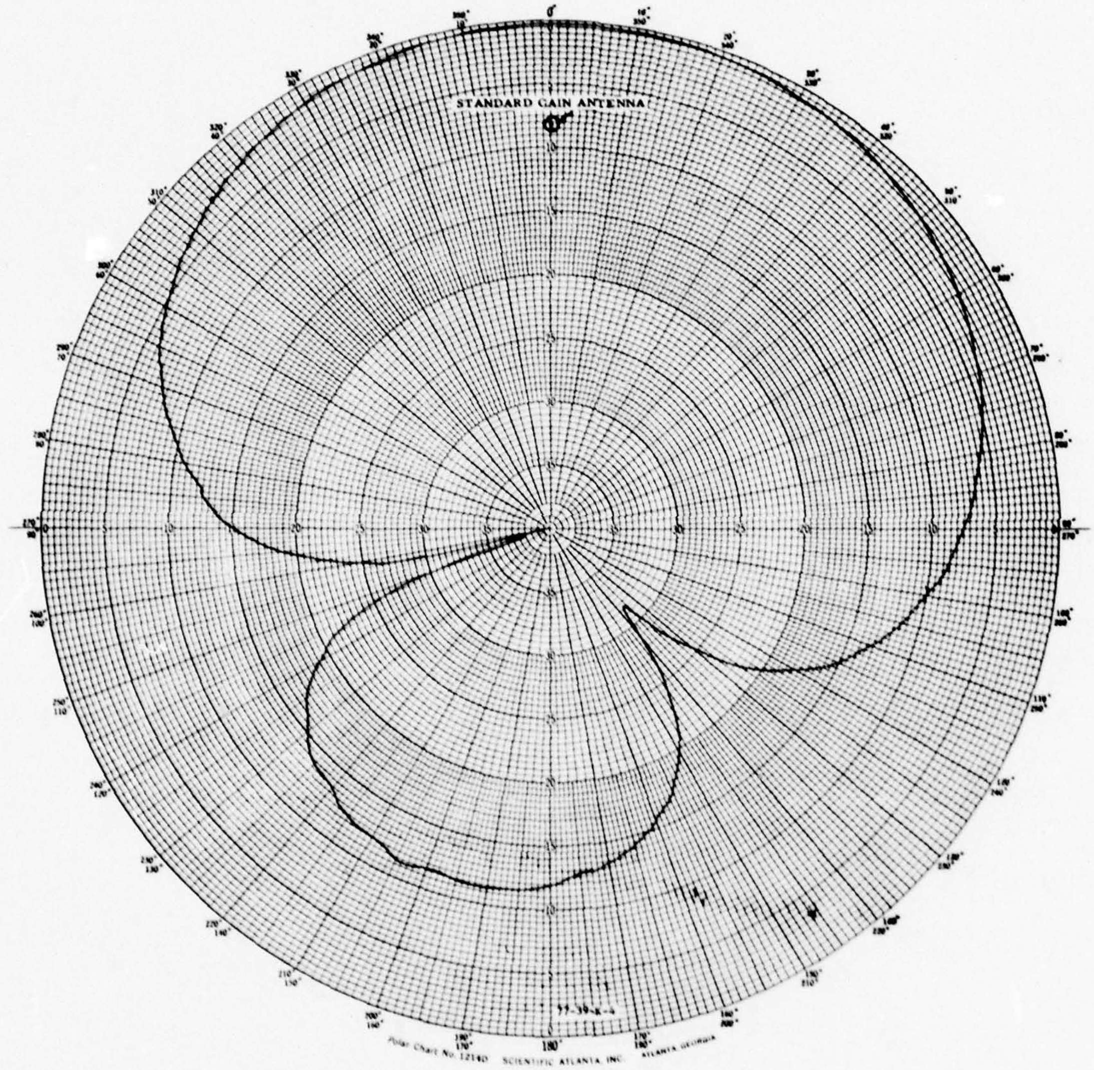


FIGURE K-4. VB-155BN HORIZONTAL RADIATION PATTERN

APPENDIX L

KRECO CO-156A VHF GROUNDED DIPOLE ANTENNA

The CO-156A Antenna shown in figure L-1 is a vertically polarized omnidirectional grounded dipole that was designed to operate with a center frequency of 122 MHz. This antenna was manufacrured by the H. Kreckman Company, Cresco, Pennsylvania and cost $60.00. The CO-156A antenna weighs 8 1/4 pounds, is 9 feet long and consists of a 22-inch long radiating element and a 23 1/2 inch long skirt which are connected together by an aluminum hub assembly instead of a non-metalic insulator. This antenna is excited by means of a grounded radiating element under the skirt.

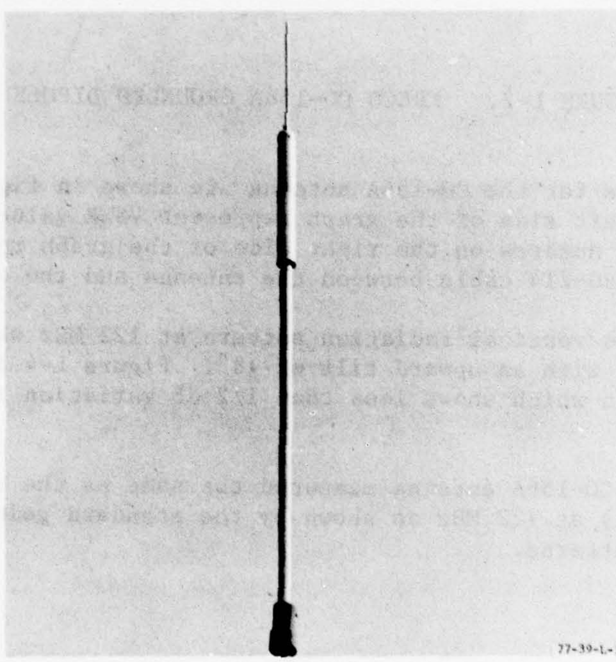


FIGURE L-1. CO-156A GROUNDED DIPOLE

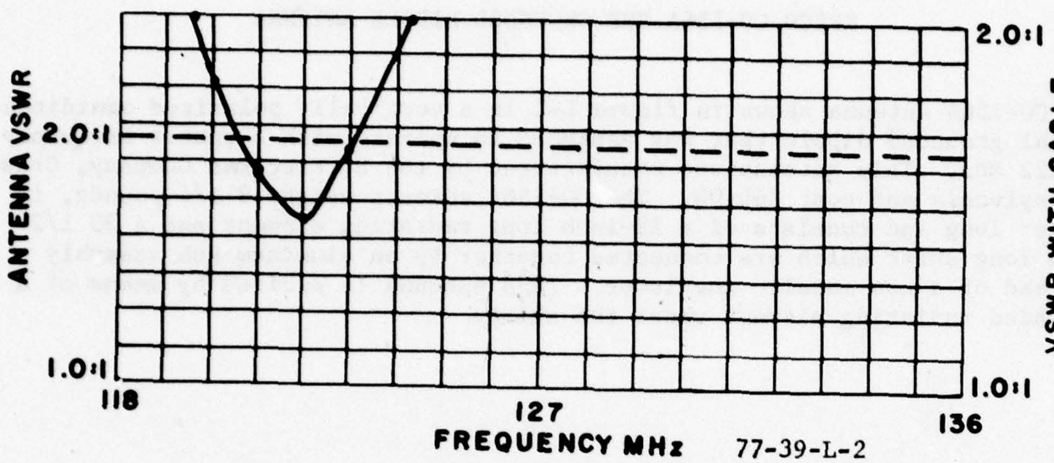


FIGURE L-2. KRECO CO-156A GROUNDED DIPOLE ANTENNA

VSWR measurements for the CO-156A antenna are shown in figure L-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with 50 foot of RG-214 cable between the antenna and the slotted line.

Figure L-3 is the vertical radiation pattern at 122 MHz which shows a vertical beamwidth of 61° with an upward tilt of 18°. Figure L-4 is the horizontal radiation pattern which shows less than 1/2 dB variation in the omnidirectional pattern.

The gain of the CO-156A antenna measured the same as the standard gain dipole (0 dBd or +2 dBi) at 122 MHz as shown by the standard gain antenna dots on the radiation patterns.

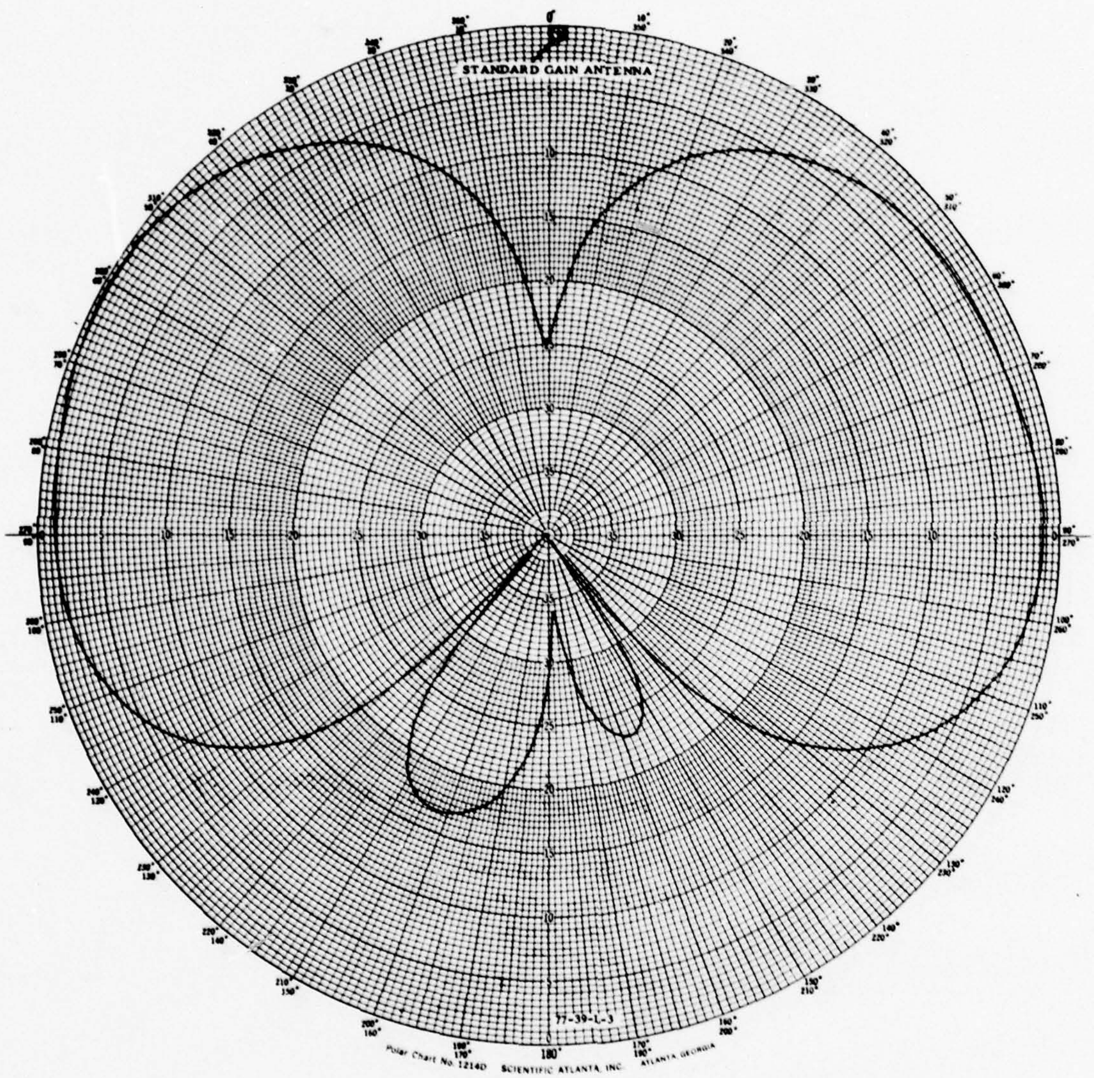


FIGURE L-3. CO-156A VERTICAL RADIATION PATTERN

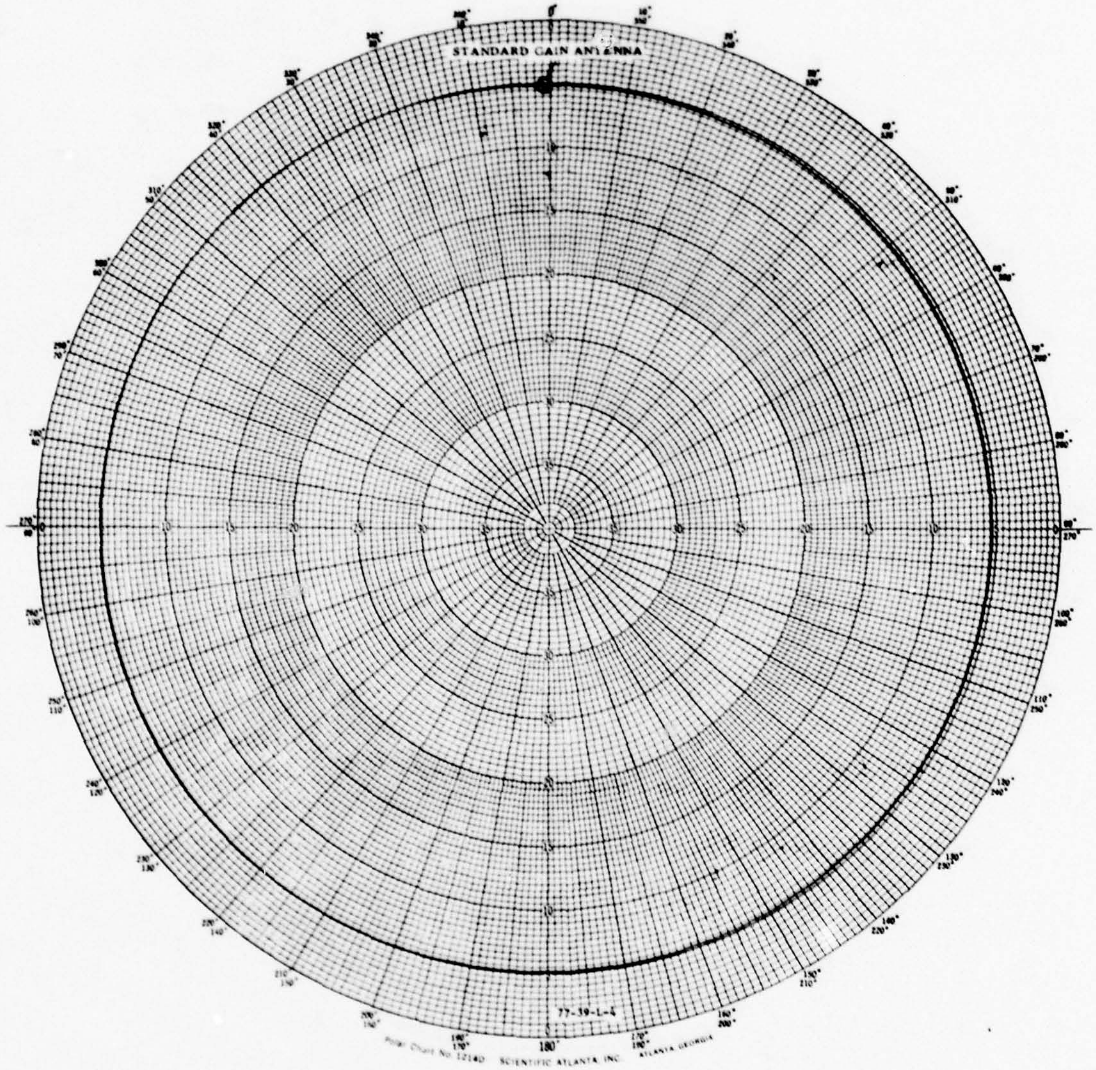


FIGURE L-4. CO-156A HORIZONTAL RADIATION PATTERN

APPENDIX M

KRECO CP-156A VHF GROUNDED DIPOLE ANTENNA WITH GROUND PLANE

The CP-156A antenna shown in figure M-1 is a vertically polarized, omnidirectional grounded dipole with a ground-plane assembly that was designed to operate with a center frequency of 122 MHz. This antenna was manufactured by the H. Kreckman Company, Cresco, Pennsylvania and cost $88.00. The CP-156A antenna weighs 10 1/4 pounds, is 9 feet long and consists of a 22-inch long radiating element and a 23 1/2 inch long skirt which are connected together by an aluminum hub assembly instead of a non-metalic insulator. The hub assembly with skirt and radiating element are assembled on a 7-foot long 1 1/4 inch thick-wall aluminum pipe. The antenna is excited by means of a grounded radiating element under the skirt. A ground-plane assembly with four 23 1/2-inch element is located 24 inches below the base of the skirt.

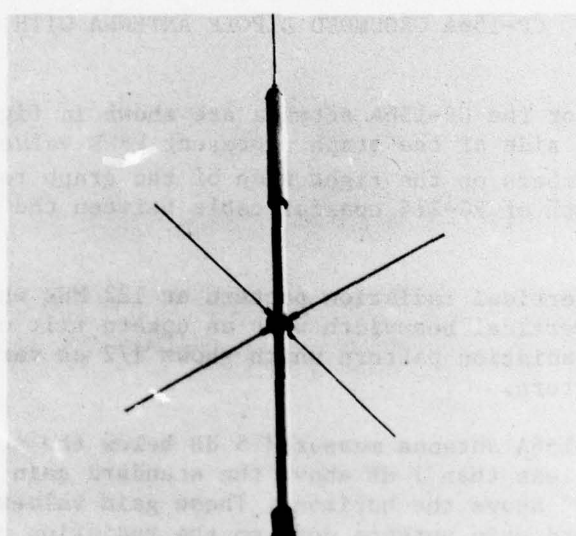


FIGURE M-1. CP-156A GROUNDED DIPOLE WITH GROUND PLANE

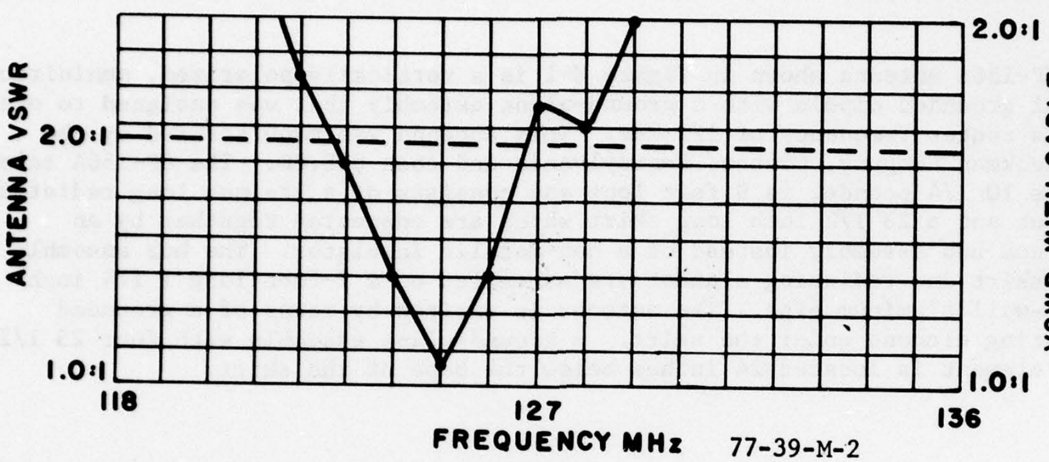


FIGURE M-2. CP-156A GROUNDED DIPOLE ANTENNA WITH GROUND PLANE

VSWR measurements for the CP-156A antenna are shown in figure M-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

Figure M-3 is the vertical radiation pattern at 122 MHz which shows the antenna has a 50° vertical beamwidth with an upward tilt of 32°. Figure M-4 is the horizontal radiation pattern which shows 1/2 dB variation in the omnidirectional pattern.

The gain of the CP-156A antenna measured 5 dB below the standard gain dipole on the horizon and less than 1 dB above the standard gain dipole at the peak of the main beam 32° above the horizon. These gain values at 122 MHz are shown by the standard gain antenna dots on the radiation patterns.

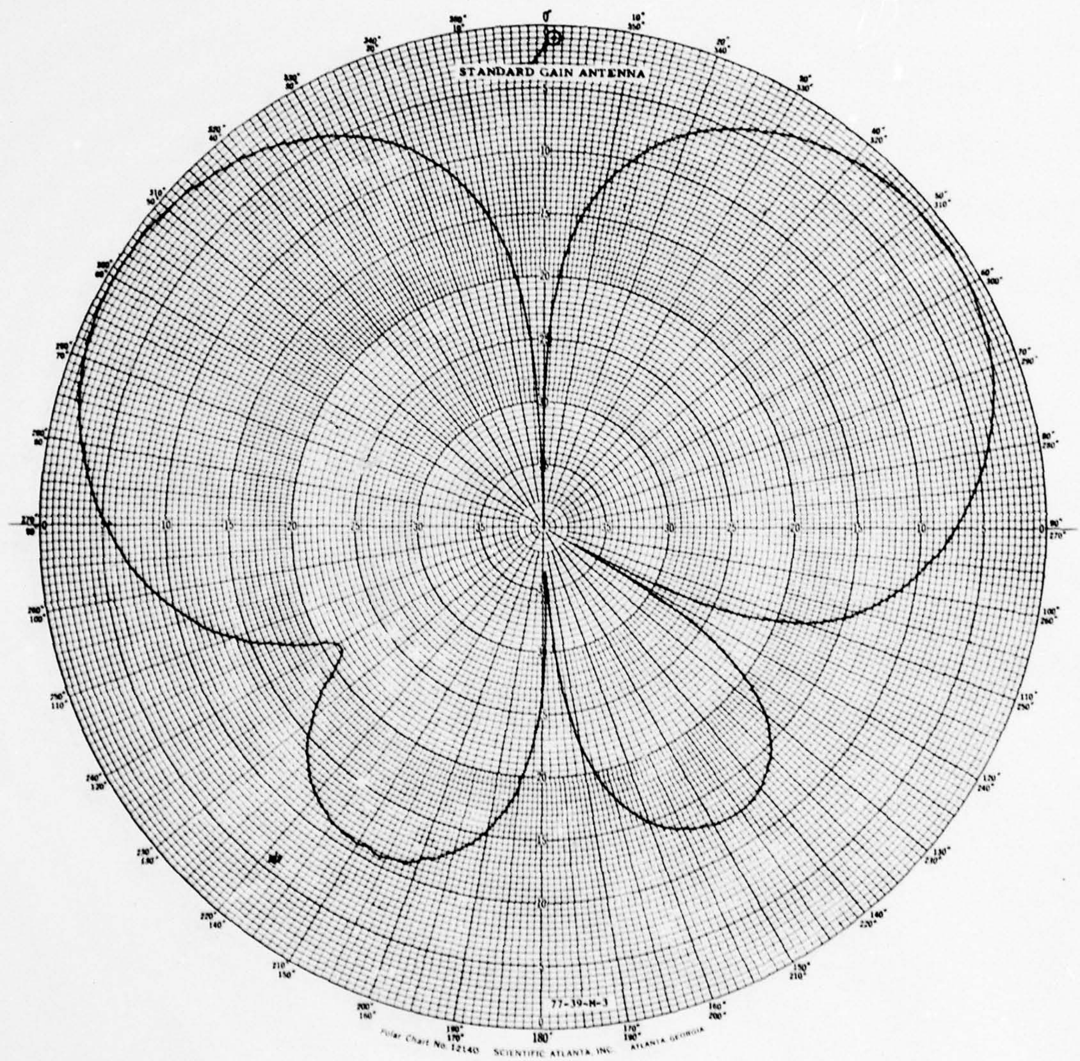


FIGURE M-3. CP-156A VERTICAL RADIATION PATTERN

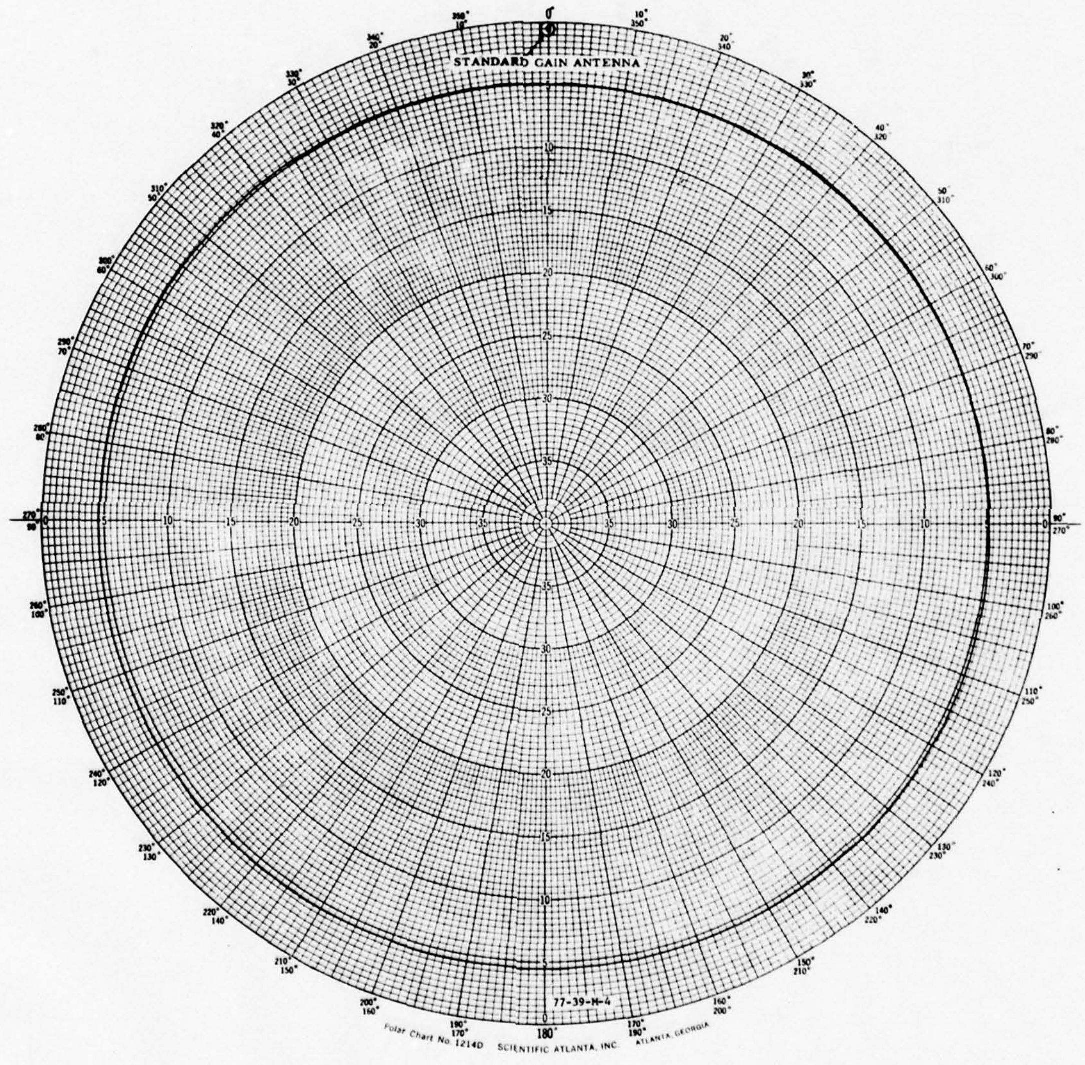


FIGURE M-4. CP-156A HORIZONTAL RADIATION PATTERN

APPENDIX N

PHELPS DODGE VHF GAIN ANTENNA

The Phelps Dodge Antenna shown in figure N-1 is a vertically polarized omnidirectional gain antenna that was designed to operate from 123 MHz to 129 MHz. This antenna was manufactured by the Phelps Dodge Communications Company, Marlboro, New Jersey, and is similar to their super stationmaster base station antenna (Cat. No. 220). The Phelps Dodge antenna weighs 27 pounds, is 190 inches long, cost $225.00 and comes equipped with a clamp set to permit mounting the antenna to a suitable support structure.

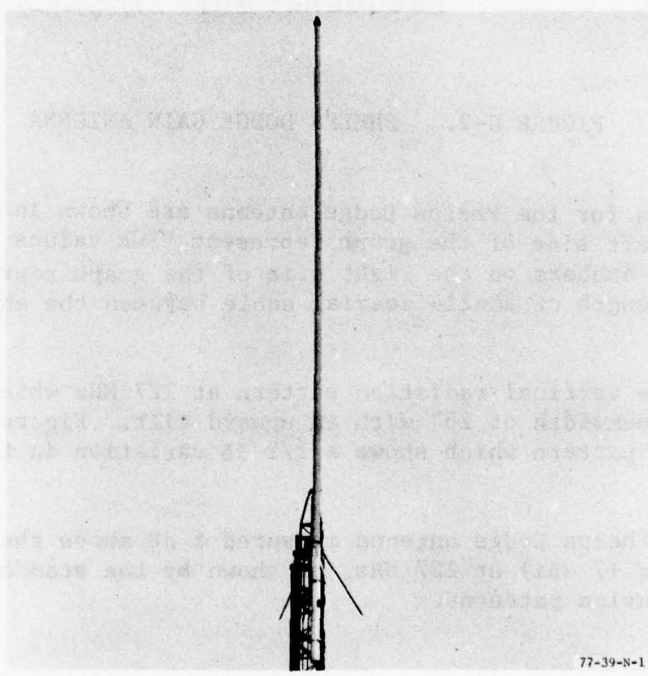


FIGURE N-1. PHELPS DODGE GAIN ANTENNA

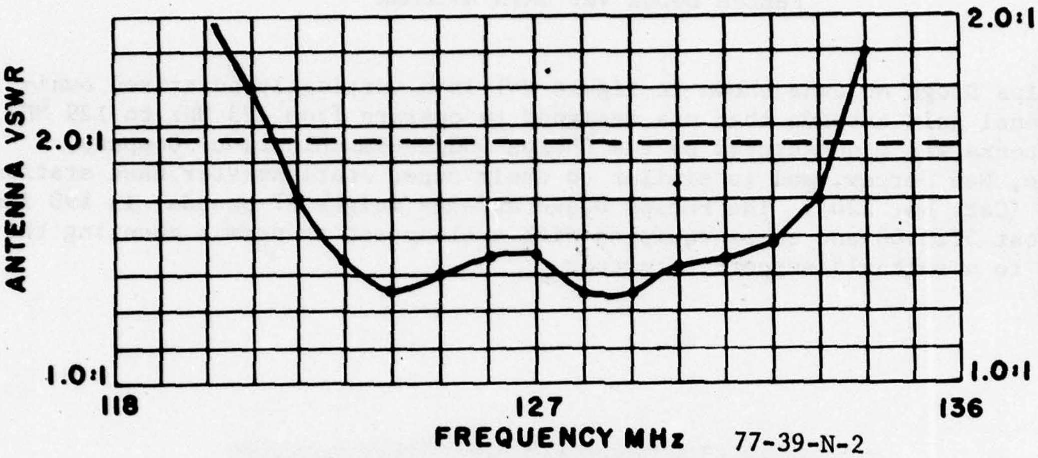


FIGURE N-2. PHELPS DODGE GAIN ANTENNA

VSWR measurements for the Phelps Dodge antenna are shown in figure N-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

Figure N-3 is the vertical radiation pattern at 127 MHz which shows the antenna has a vertical beamwidth of 25° with an upward tilt. Figure N-4 is the horizontal radiation pattern which shows a 1/2 dB variation in the omnidirection pattern.

The gain of the Phelps Dodge antenna measured 5 dB above the standard gain dipole (+5 dBd or +7 dBi) at 127 MHz, as shown by the standard gain antenna dots on the radiation patterns.

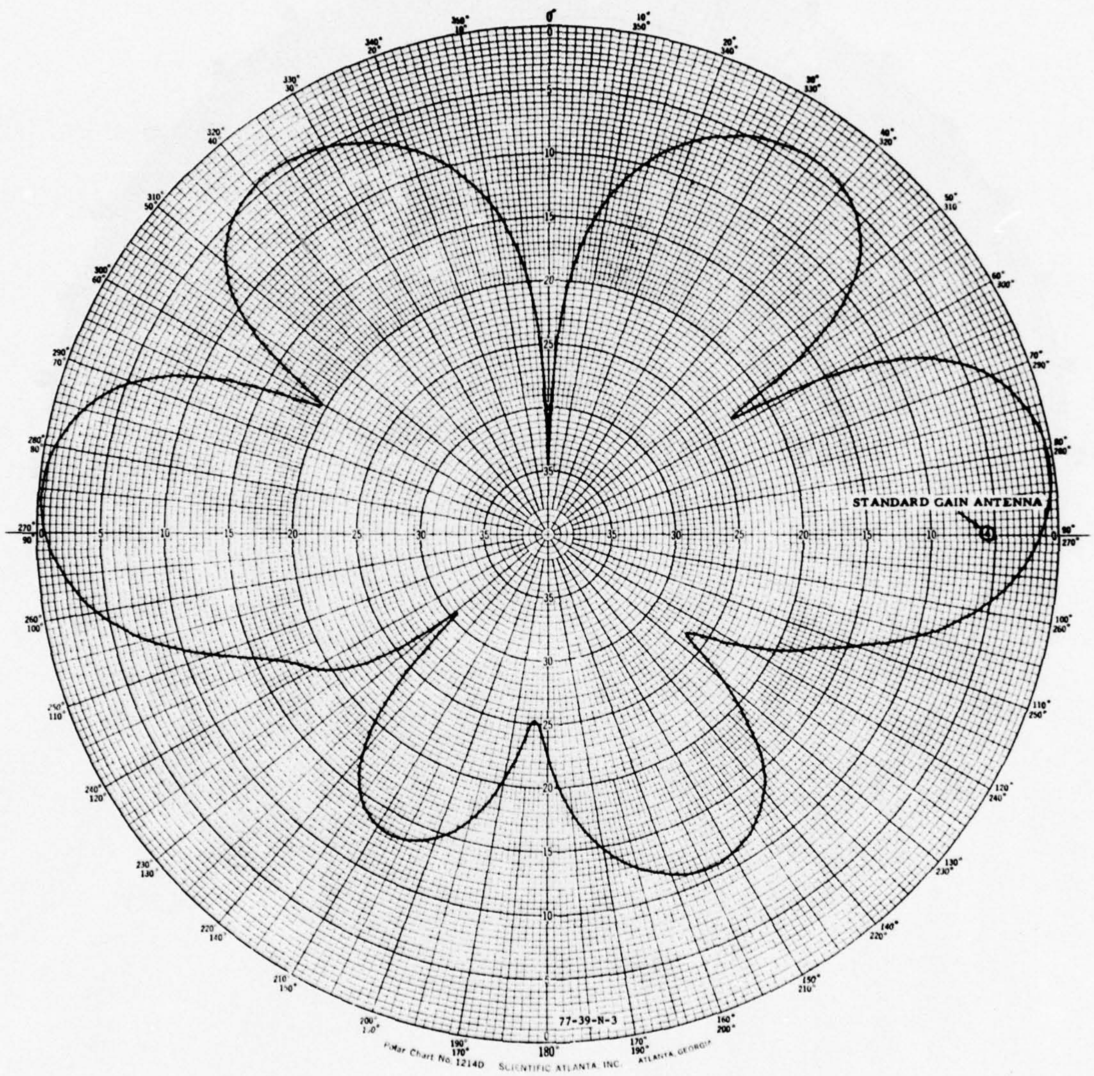


FIGURE N-3. PHELPS DODGE VERTICAL RADIATION PATTERN

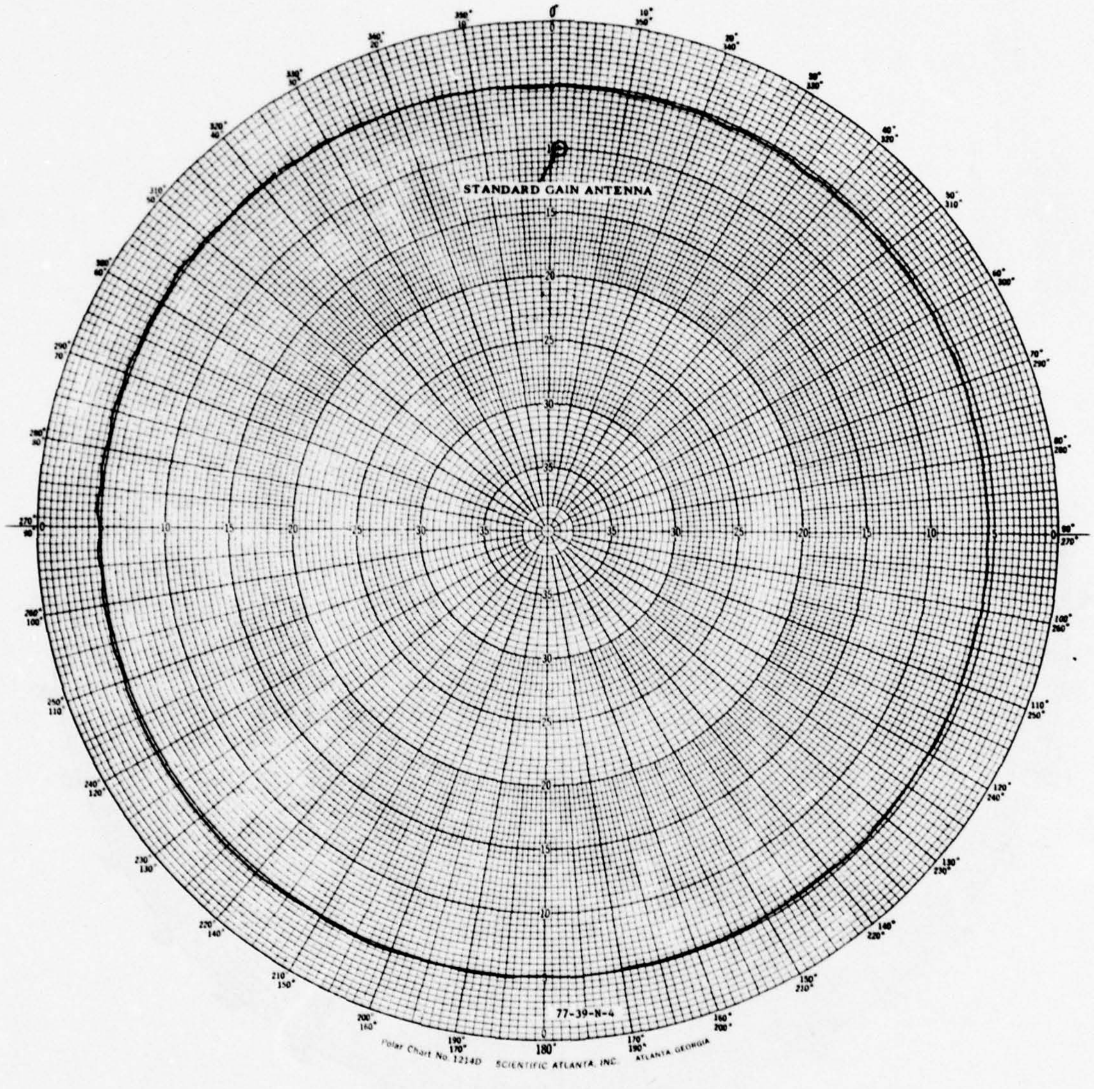


FIGURE N-4. PHELPS DODGE HORIZONTAL RADIATION PATTERN

APPENDIX O

RADIONICS 5731 VHF DIPOLE ANTENNA

The RAD-5731 antenna shown in figure O-1 is a vertically polarized omnidirectional, broadband, ground-independent antenna that was designed to operate in the VHF A/G communications frequency band of 118 to 136 MHz. This antenna was manufactured by Radionics Incorporated, Webster, New York, and weighs 2 1/4 pounds, is 44 inches long and 2 1/4 inches in diameter. The RAD-5731 antenna has a DC grounded radiating element for lightning surge and static protection and is mounted on a supporting structure by clamping the choke section at the base of the antenna.

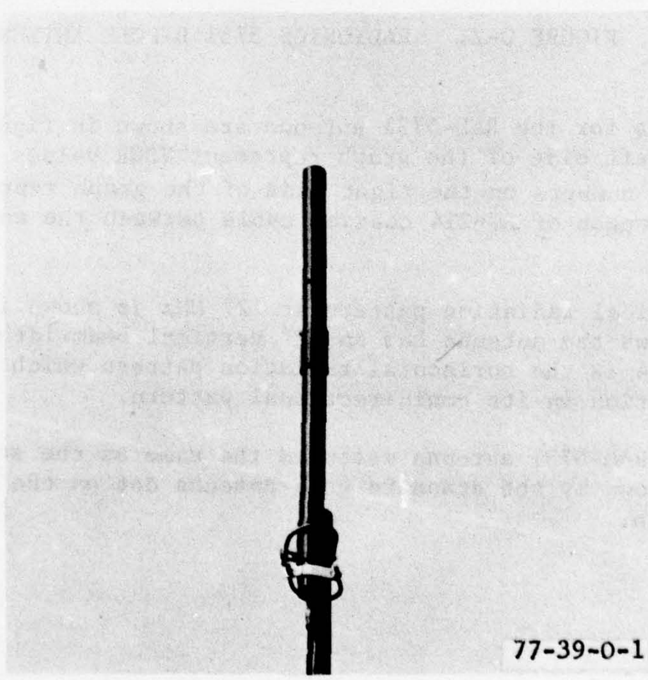


FIGURE O-1. RAD-5731 VHF DIPOLE ANTENNA

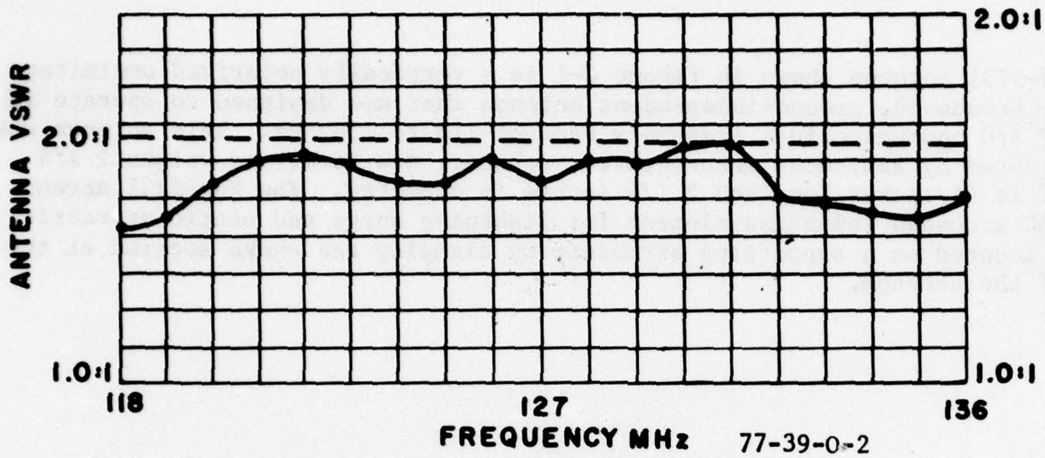


FIGURE O-2. RADIONICS 5731 DIPOLE ANTENNA

VSWR measurements for the RAD-5731 antenna are shown in figure O-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with a 50 foot length of RG-214 coaxial cable between the antenna and the slotted line.

The antenna vertical radiation pattern at 127 MHz is shown in figure O-3. This pattern shows the antenna has an 82° vertical beamwidth with an upward tilt. Figure O-4 is the horizontal radiation pattern which shows this antenna has a 1 dB variation in its omnidirectional pattern.

The gain of the RAD-5731 antenna measured the same as the standard gain dipole at 127 MHz as shown by the standard gain antenna dot on the vertical radiation pattern.

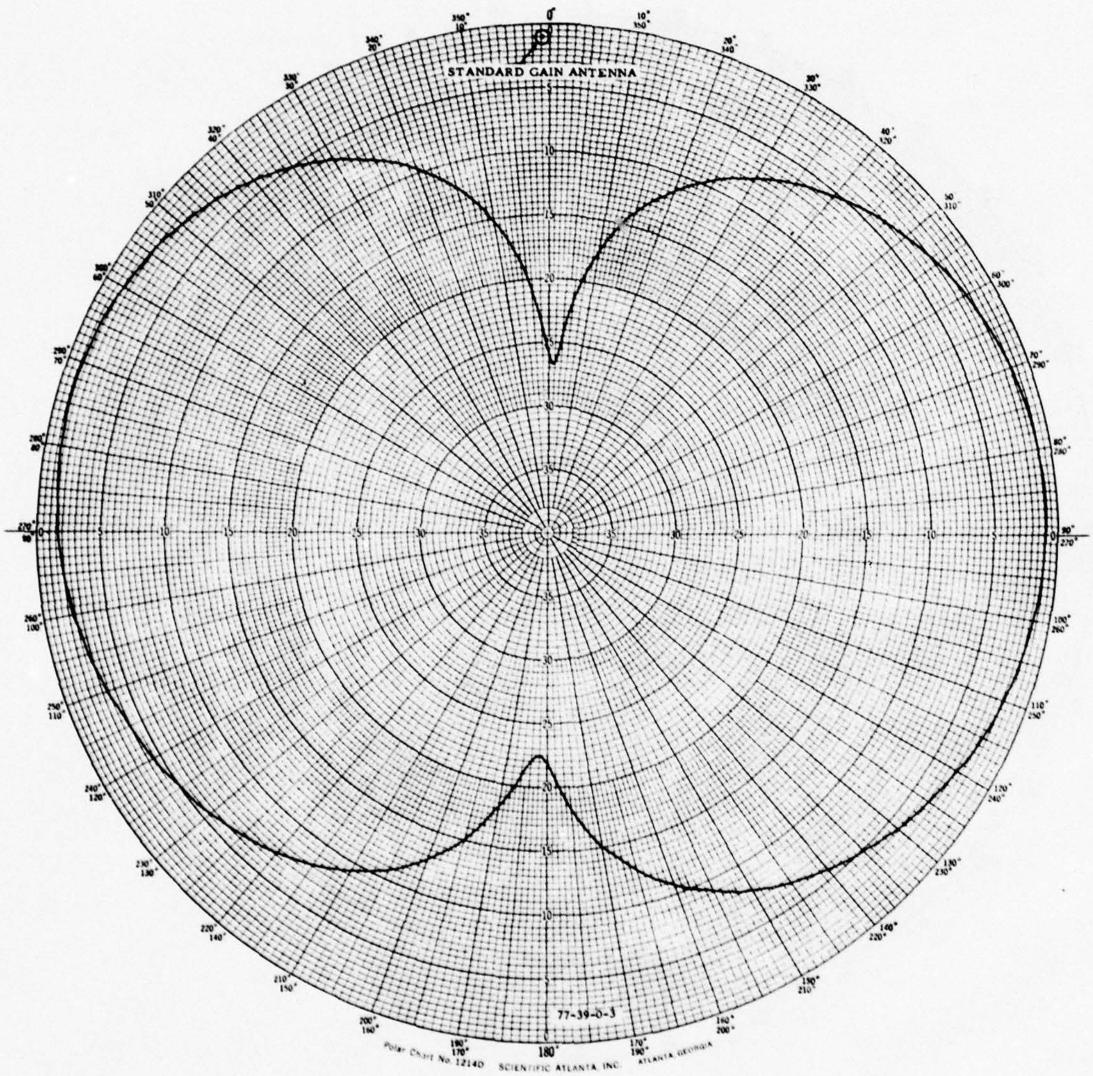


FIGURE O-3. RAD-5731 VERTICAL RADIATION PATTERN

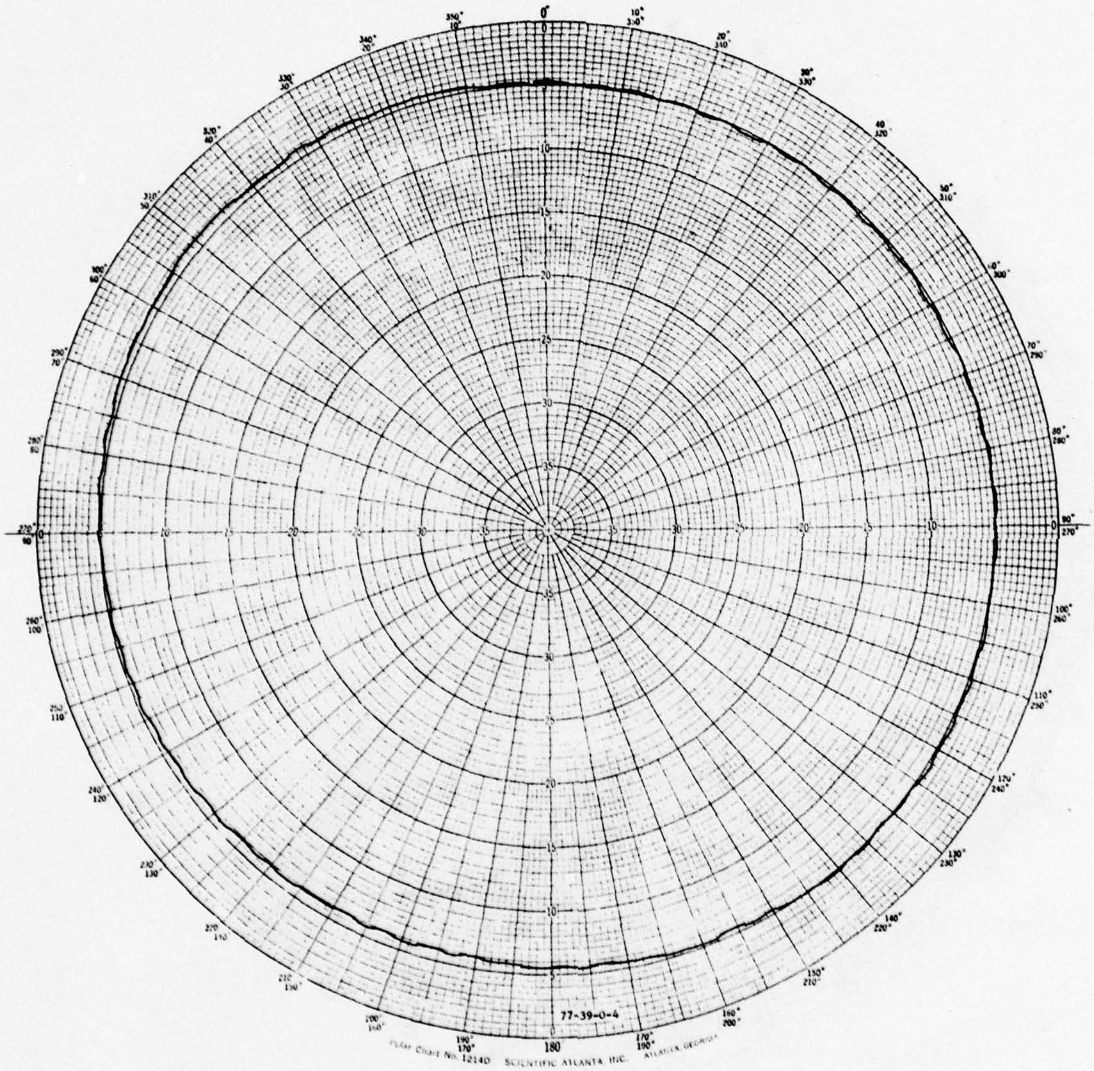


FIGURE O-4. RAD-5731 HORIZONTAL RADIATION PATTERN

APPENDIX P

RADIONICS 5831 UHF DIPOLE ANTENNA

The RAD-5831 antenna shown in figure P-1 is a vertically polarized omni-directional, broadband, ground-independent antenna that was designed to operate in the military A/G communications frequency band of 225 to 400 MHz. This antenna was manufactured by Radionics Incorporated, Webster, New York and weighs 1 3/4 pounds, is 28 3/4 inches long and 2 1/4 inches in diameter. The RAD-5831 antenna has a DC grounded radiating element for lightning surge and static protection and is mounted to a supporting structure by clamping the choke section at the base of the antenna.

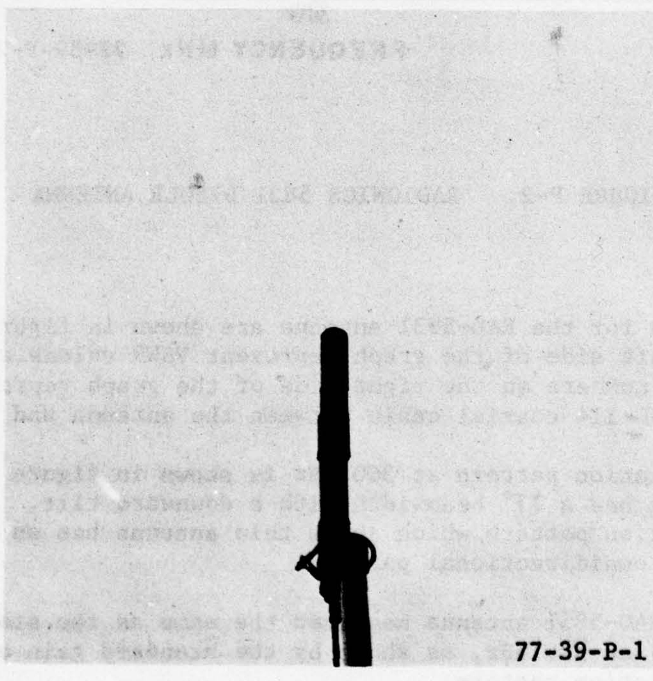
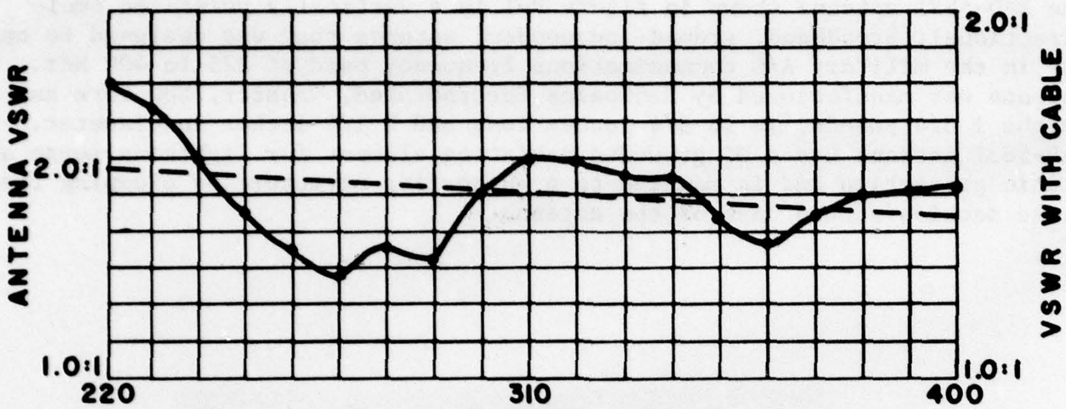


FIGURE P-1. RAD-5831 UHF DIPOLE ANTENNA



77-39-P-2

FIGURE P-2. RADIONICS 5831 DIPOLE ANTENNA

VSWR measurements for the RAD-5831 antenna are shown in figure P-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with 50 foot of RG-214 coaxial cable between the antenna and the slotted line.

The vertical radiation pattern at 300 MHz is shown in figure P-3. This pattern shows the antenna has a 77° beamwidth with a downward tilt. Figure P-4 is the horizontal radiation pattern which shows this antenna has an approximate 1 dB variation in its omnidirectional pattern.

The gain of the RAD-5831 antenna measured the same as the standard gain dipole (0 dBd or +2 dBi) at 300 MHz, as shown by the standard gain antenna dot on the vertical radiation pattern.

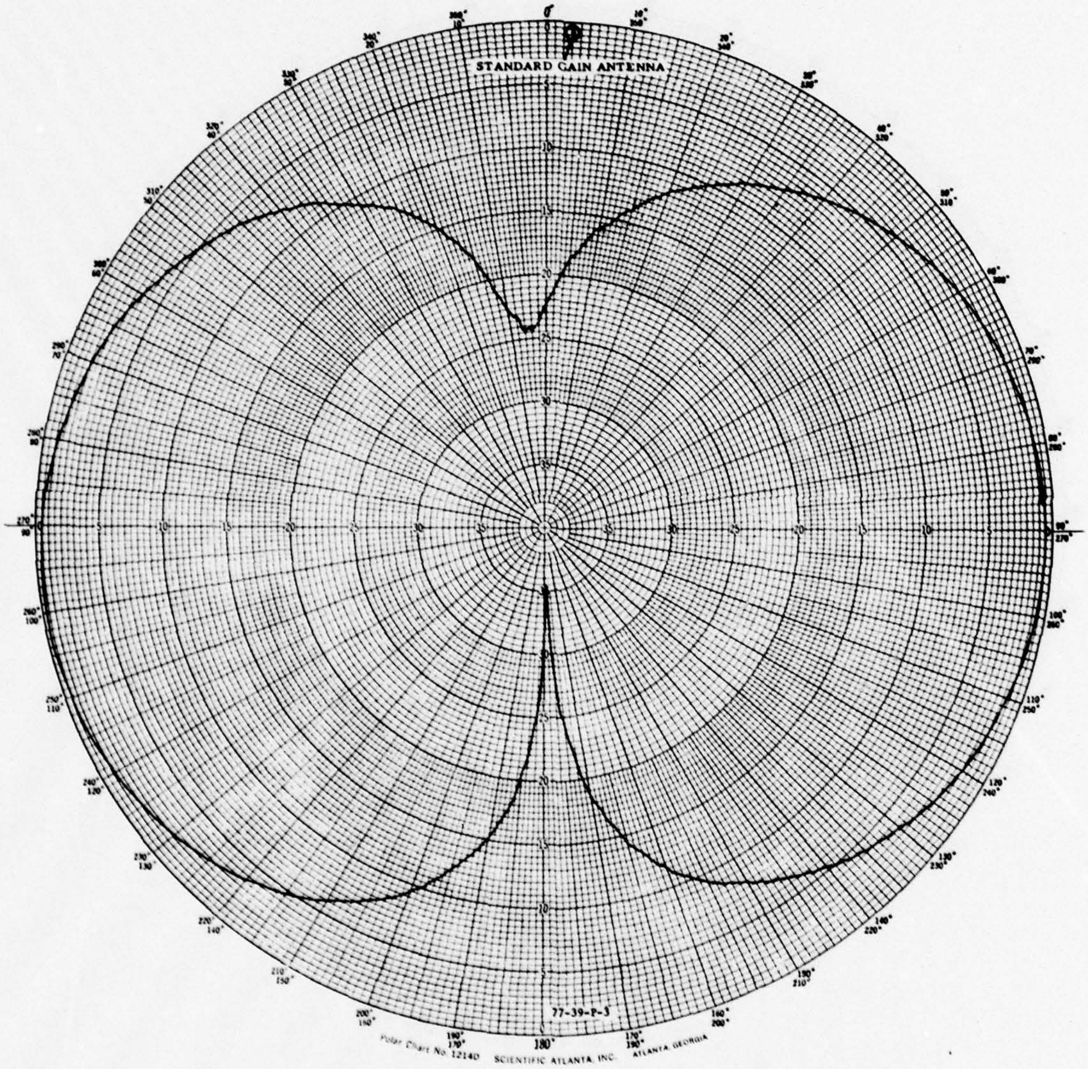


FIGURE P-3. RAD-5831 VERTICAL RADIATION PATTERN

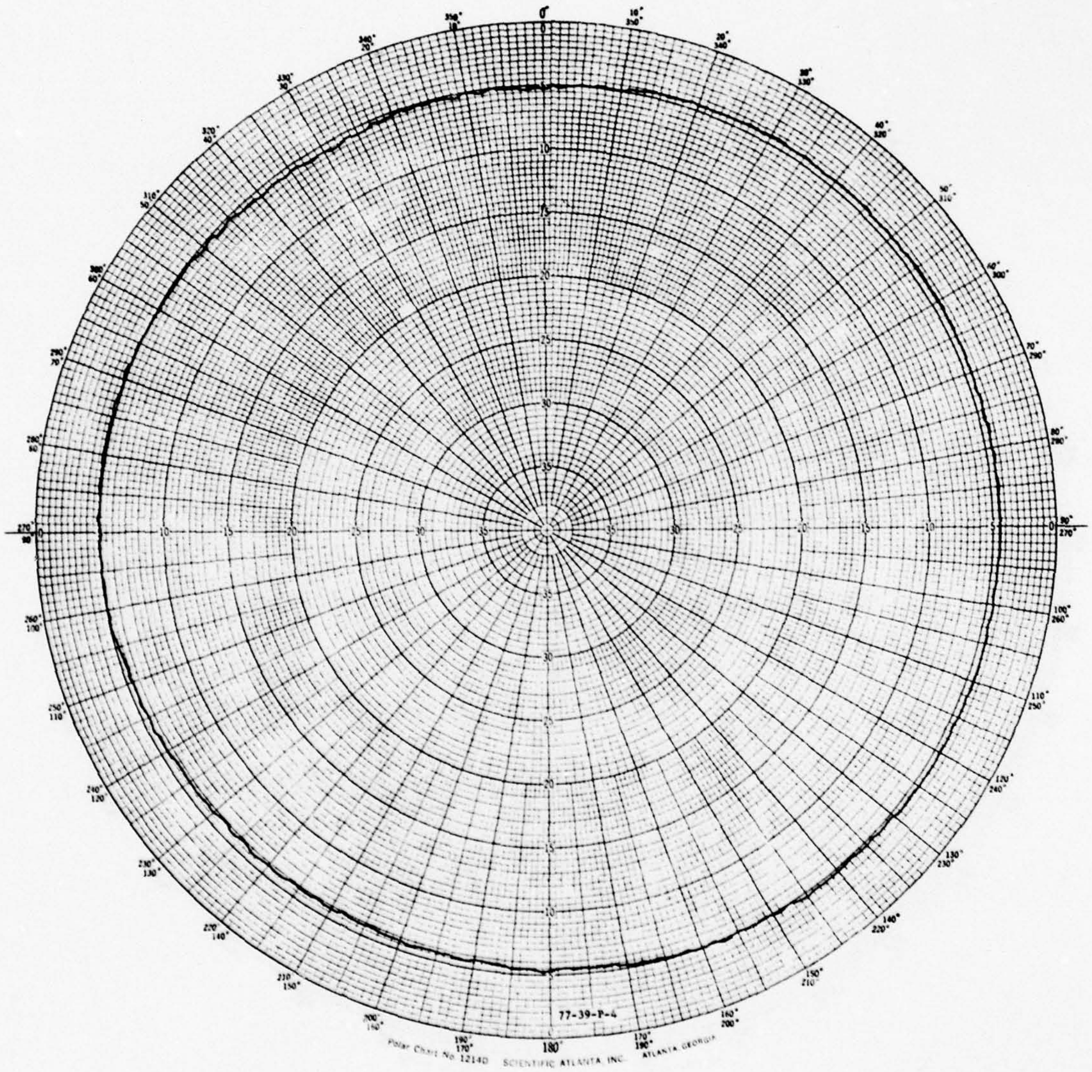


FIGURE P-4. RAD-5831 HORIZONTAL RADIATION PATTERN

APPENDIX Q

TACO D-2216 VHF DIPOLE ANTENNA

The D-2216 antenna shown in figure Q-1 is a vertically polarized broadband omnidirectional half-wave dipole antenna that was designed to operate in the extended VHF frequency range of 116 to 150 MHz. This antenna was manufactured by the Technical Appliance Corporation, Sherburne, New York and cost $170.00, weighs 3 1/2 pounds, is 55 inches long by 1 1/2 inches in diameter. The antenna elements are sealed inside a filament wound fiberglass enclosure.

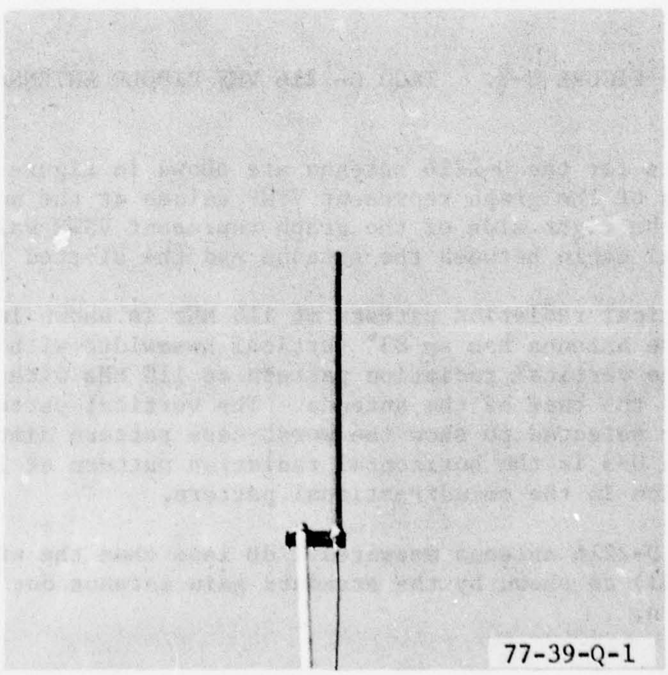


FIGURE Q-1. D-2216 VHF DIPOLE ANTENNA

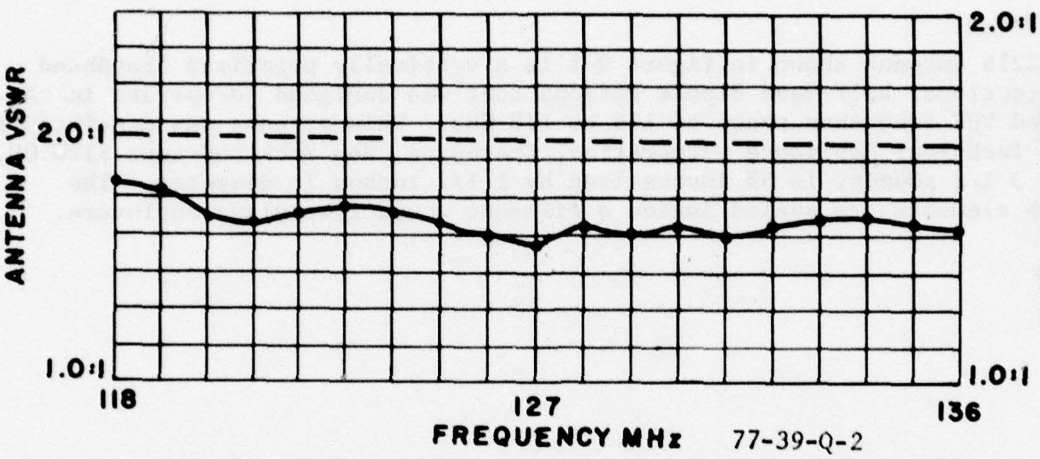


FIGURE Q-2. TACO D-2216 VHF DIPOLE ANTENNA

VSWR measurements for the D-2216 antenna are shown in figure Q-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal. The numbers on the right side of the graph represent VSWR values with 50 foot of RG-214 coaxial cable between the antenna and the slotted line.

The antenna vertical radiation pattern at 118 MHz is shown in figure Q-3. This pattern shows the antenna has an 83° vertical beamwidth with a downward tilt. Figure Q-4 is the vertical radiation pattern at 118 MHz with a 5-foot length of pipe attached to the base of the antenna. The vertical patterns at the low end of the band were selected to show the worst-case pattern distortion for this antenna. Figure Q-5 is the horizontal radiation pattern at 127 MHz which shows a 1/2 dB variation in the omindirectional pattern.

The gain of the D-2216 antenna measured 1 dB less than the standard gain dipole (-1 dBd or +1 dBi) as shown by the standard gain antenna dot on the horizontal radiation pattern.

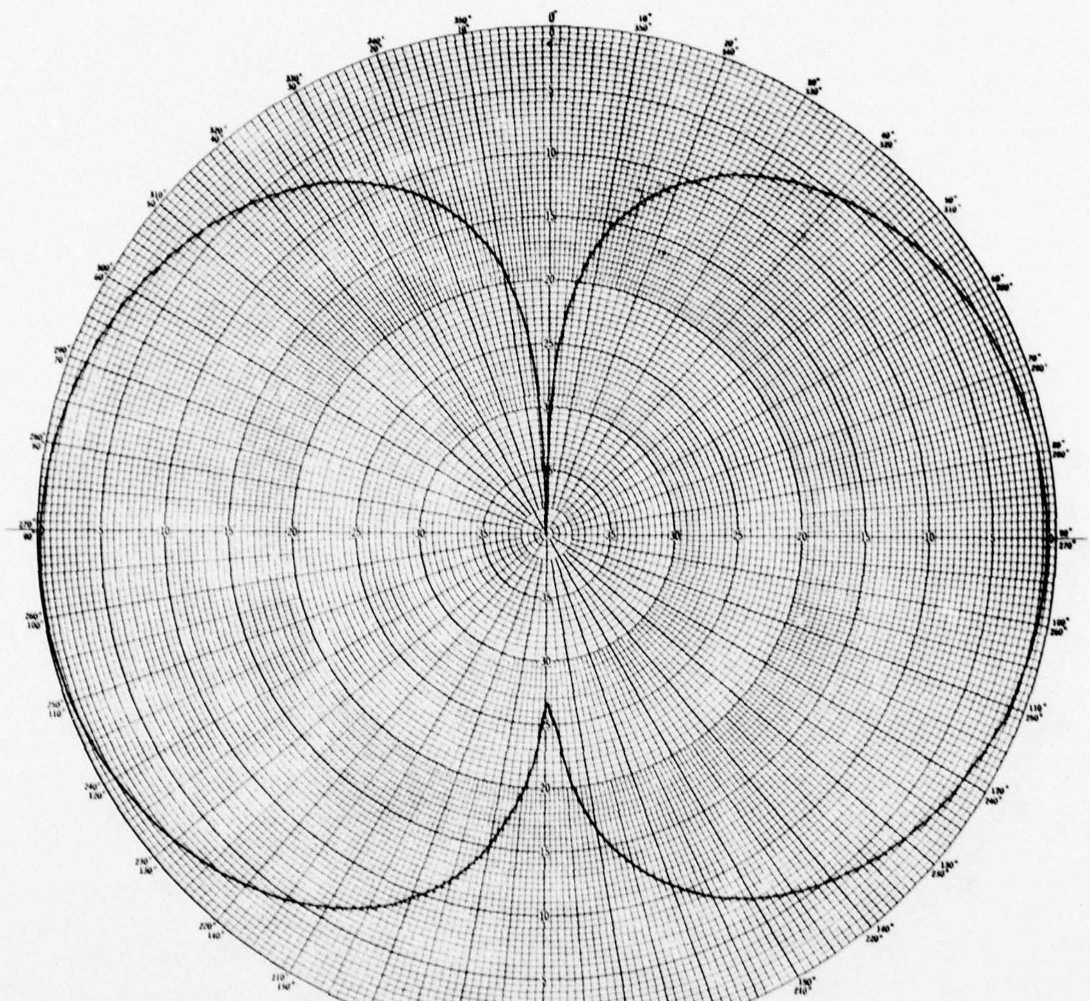


FIGURE Q-3. D-2216 VERTICAL RADIATION PATTERN

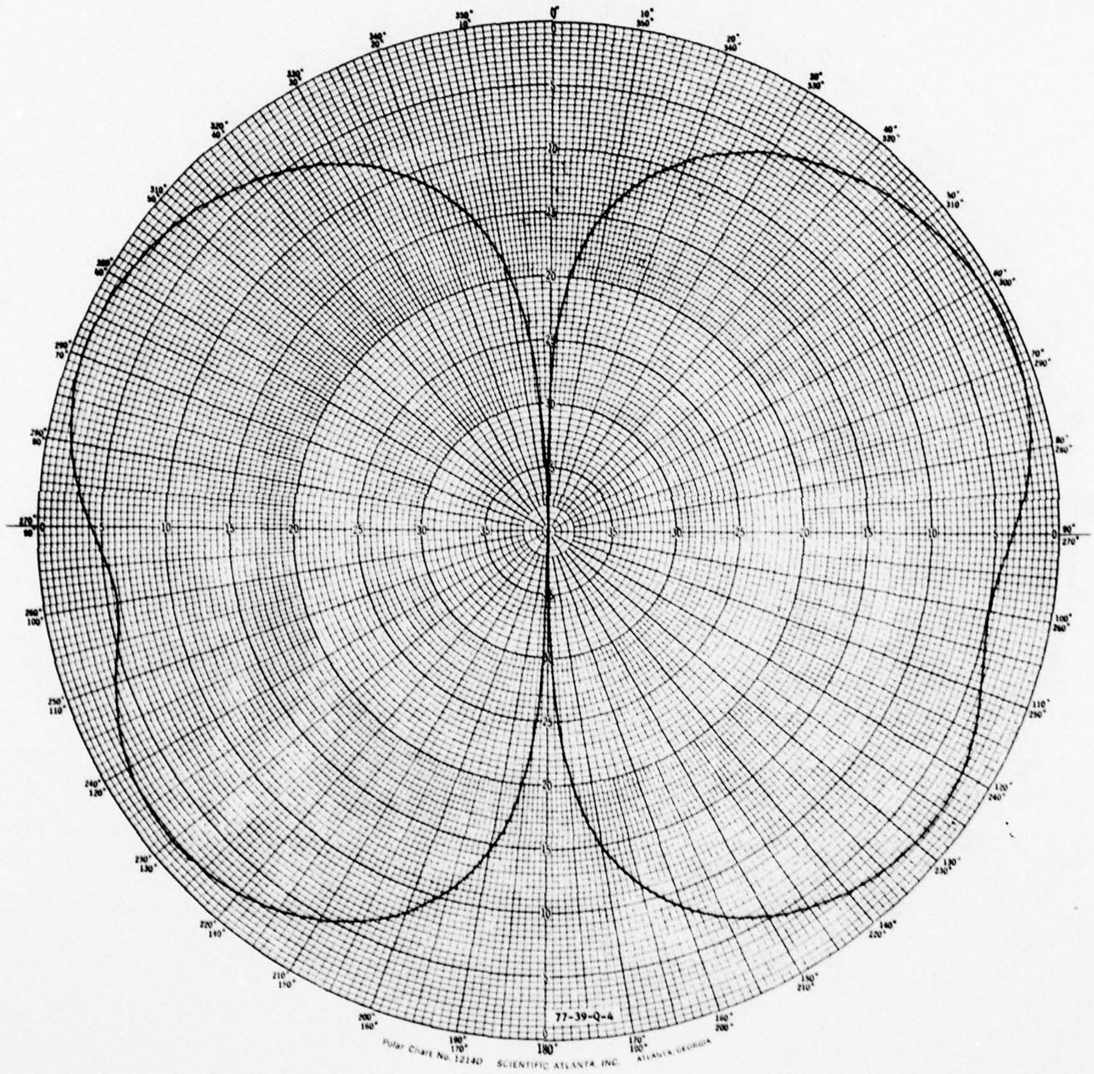


FIGURE Q-4. D-2216 DISTORTED VERTICAL RADIATION PATTERN

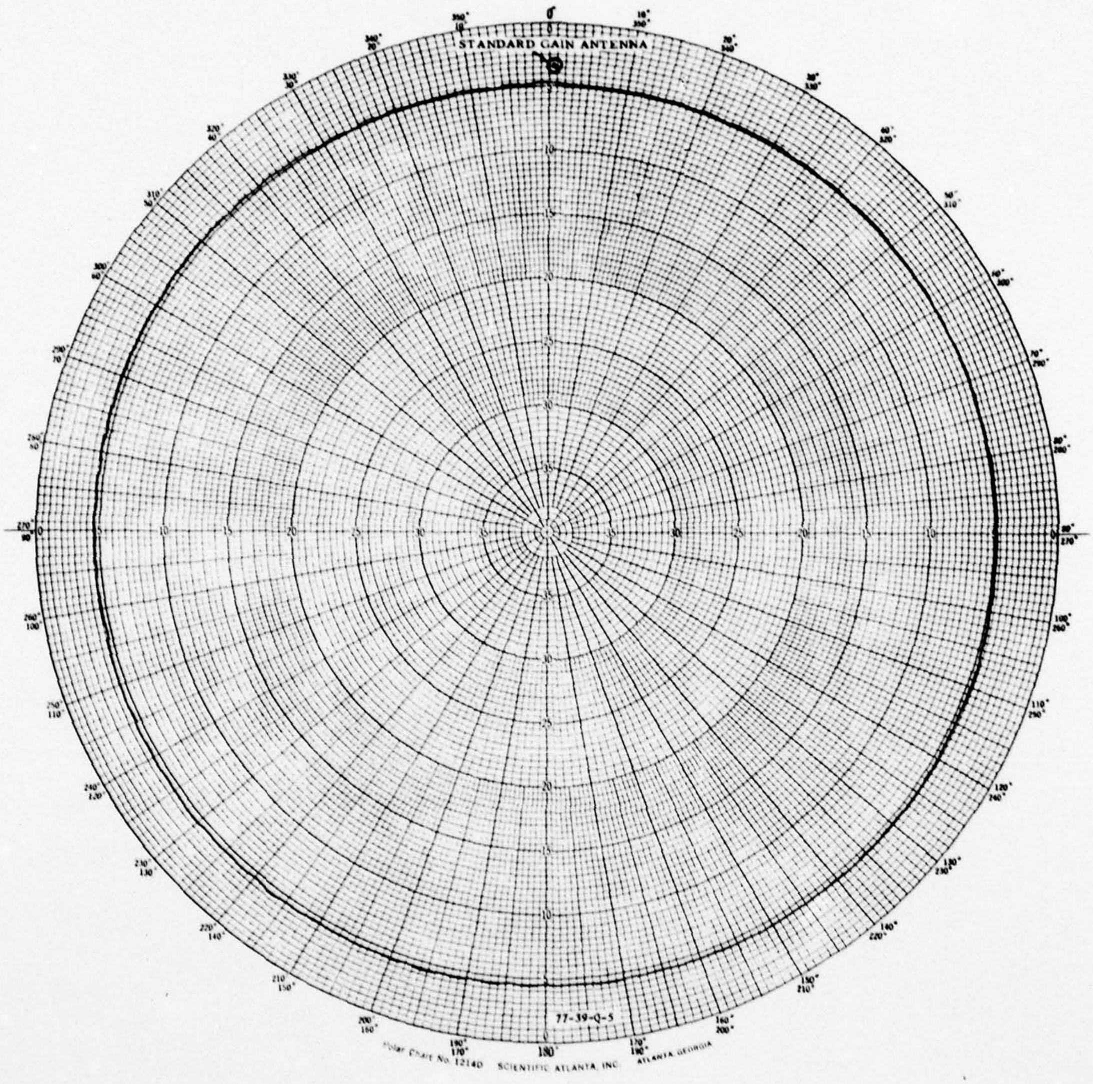


FIGURE Q-5. D-2216 HORIZONTAL RADIATION PATTERN

APPENDIX R

TACO D-2217 UHF DIPOLE ANTENNA

The D-2217 antenna shown in figure R-1 is a vertically polarized broadband omnidirectional, halfwave dipole antenna that was designed to operate in the military A/G communication frequency band of 225 to 400 MHz. This antenna was manufactured by the Technical Appliance Corporation, Sherburne, New York, and cost $110.00, weighs 2 pounds, is 32 1/2 inches long, and 1 1/2 inches in diameter. The antenna elements are sealed inside a filament wound fiberglass enclosure.

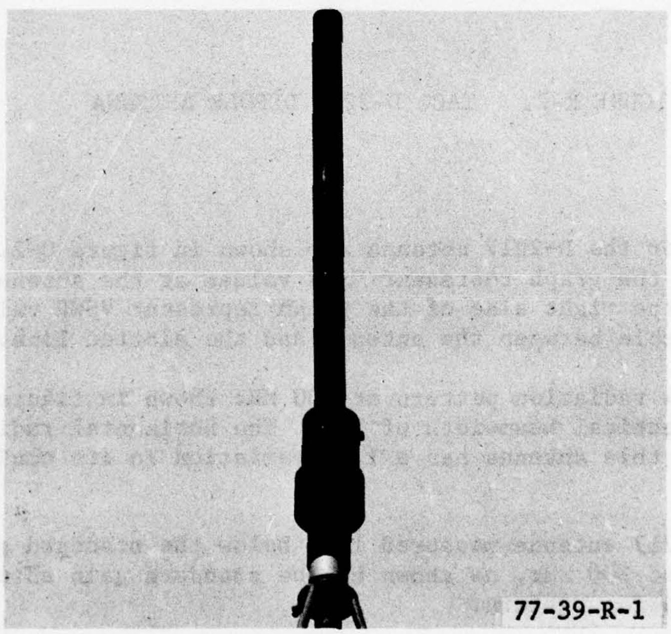


FIGURE R-1. D-2217 UHF DIPOLE ANTENNA

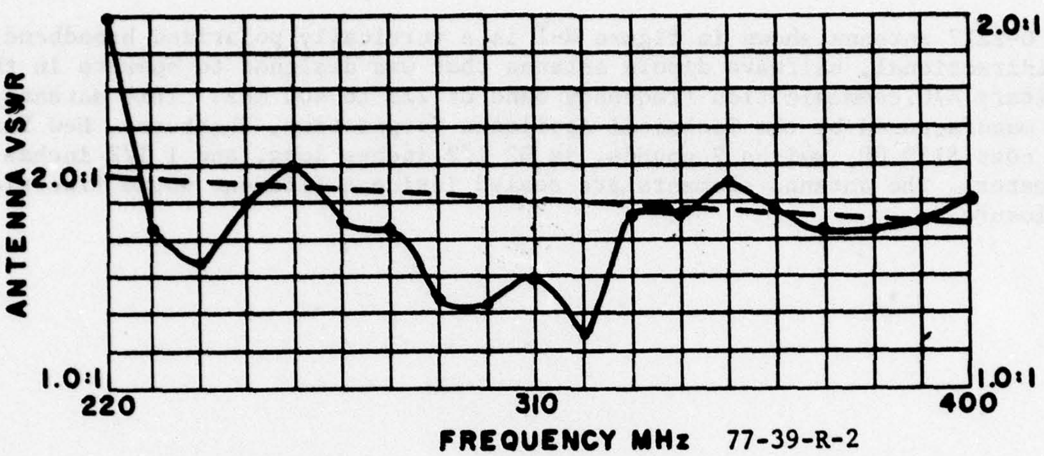


FIGURE R-2. TACO D-2217 DIPOLE ANTENNA

VSWR measurements for the D-2217 antenna are shown in figure Q-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with 50 foot of RG-214 cable between the antenna and the slotted line.

The antenna vertical radiation pattern at 300 MHz shown in figure R-3 shows the antenna has a vertical beamwidth of 75°. The horizontal radiation pattern in figure R-4 shows this antenna has a 1 dB variation in its omnidirectional pattern.

The gain of the D-2217 antenna measured 1 dB below the standard gain dipole (-1 dBd or +1 dBi) at 300 MHz, as shown by the standard gain antenna dot on the horizontal radiation pattern.

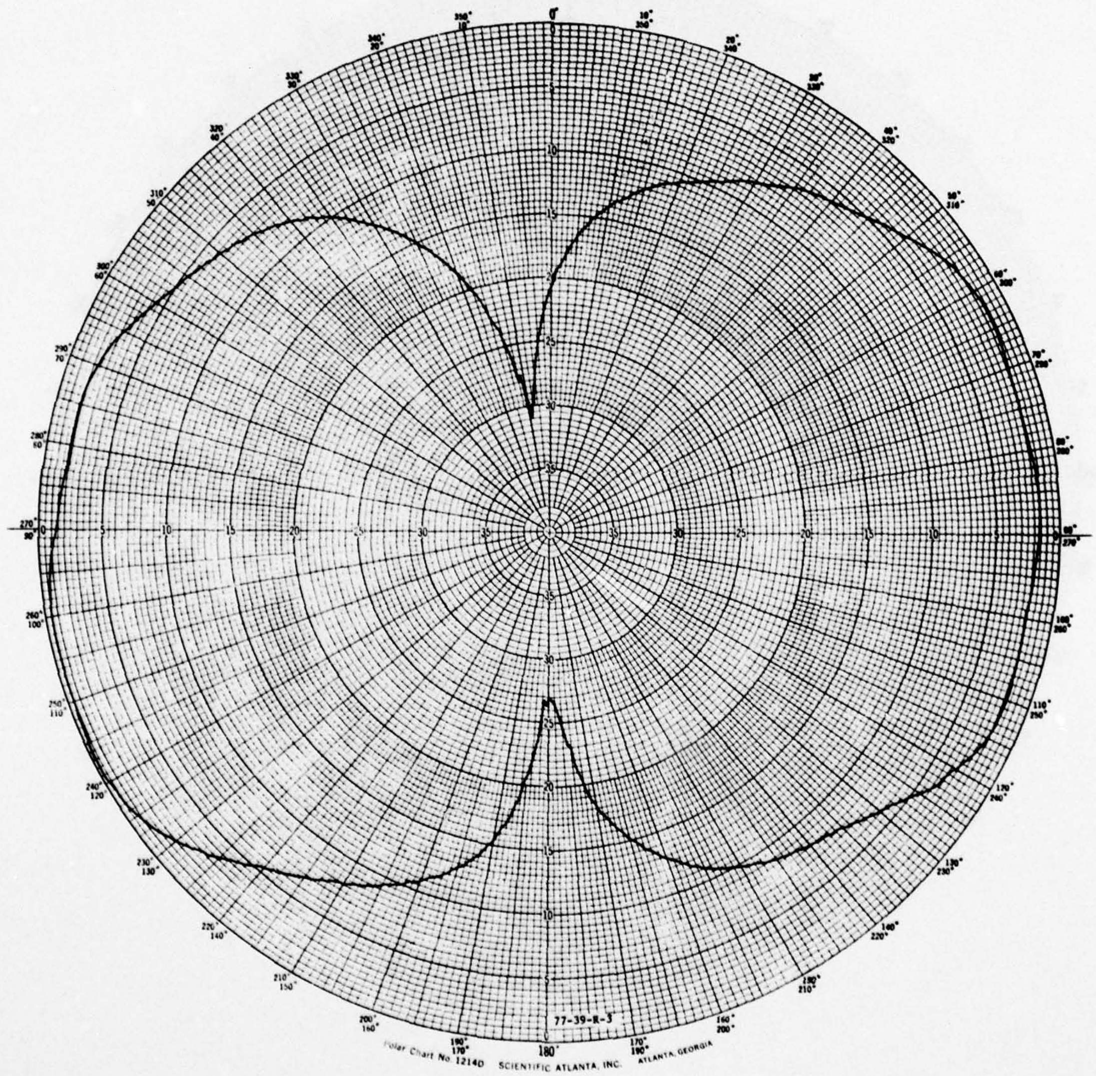


FIGURE R-3. D-2217 VERTICAL RADIATION PATTERN

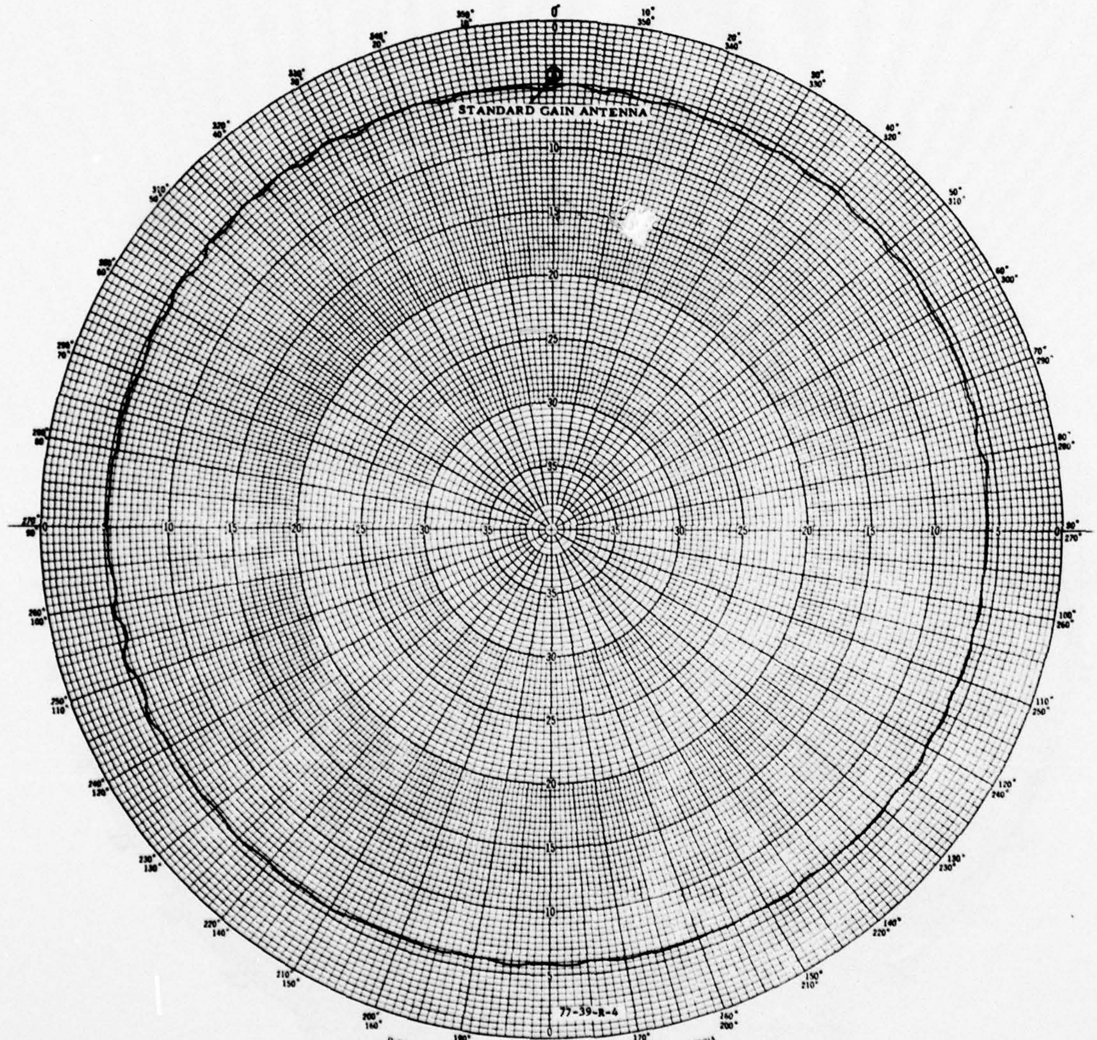


FIGURE R-4. D-2217 HORIZONTAL RADIATION PATTERN

APPENDIX S

TACO D-2213 (V-U) COLLINEAR ARRAY

The D-2213 antenna array shown in figure S-1 contains both a VHF and a UHF antenna arranged in a collinear manner and sealed inside a filament wound fiberglass enclosure. Both antennas are vertically polarized, broadband, omnidirectional, half-wave dipoles that operate independently with more than 30 dB of isolation between their antenna elements. The upper VHF antenna was designed to operate in the extended VHF A/G communications frequency band of 116 to 150 MHz and the lower UHF antenna was designed to operate in the military A/G communications frequency band of 225 to 400 MHz.

This antenna array was manufactured by the Technical Appliance Corporation, Sherburne, New York and cost $880.00, weighs 12 pounds, and is 85 inches long. A molded fiberglass clamp on the antenna base is used to mount this antenna on a 3-inch diameter support mast.

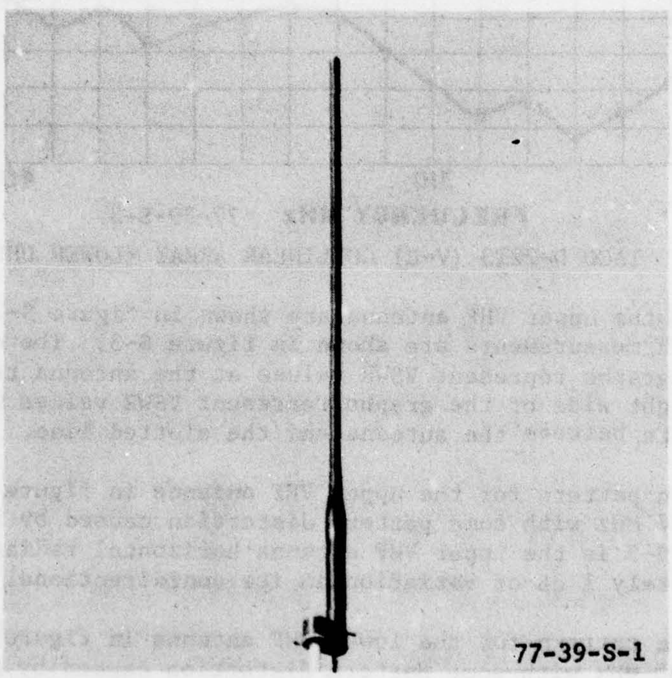


FIGURE S-1. D-2213 (V-U) ARRAY

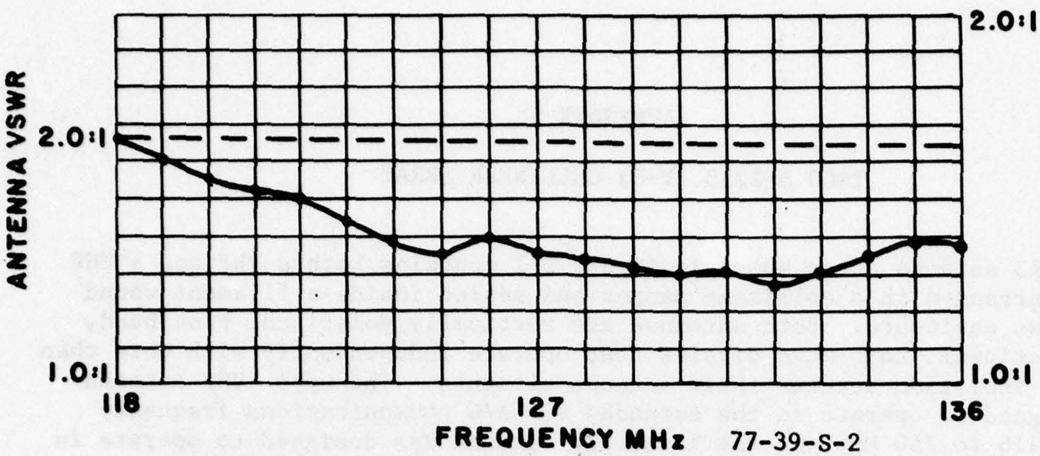


FIGURE S-2. TACO D-2213 (V-U) COLLINEAR ARRAY (UPPER VHF)

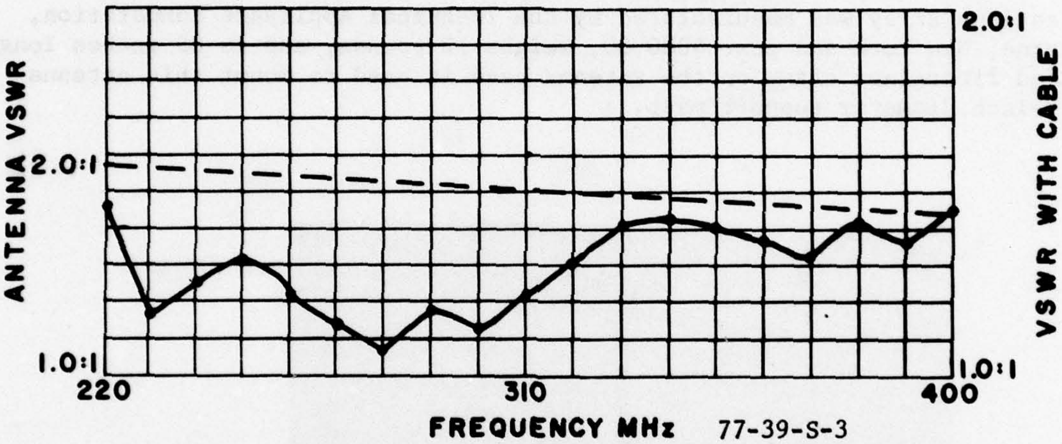


FIGURE S-3. TACO D-2213 (V-U) COLLINEAR ARRAY (LOWER UHF)

VSWR measurements for the upper VHF antenna are shown in figure S-2 and the lower UHF antenna VSWR measurements are shown in figure S-3. The numbers on the left side of the graphs represent VSWR values at the antenna terminals and the numbers on the right side of the graphs represent VSWR values with 50 foot of RG-214 coaxial cable between the antenna and the slotted line.

The vertical radiation pattern for the upper VHF antenna in figure S-4 shows a 76° beamwidth at 127 MHz with some pattern distortion caused by the lower UHF antenna. Figure S-5 is the upper VHF antenna horizontal radiation pattern which shows approximately 1 dB of variation in its omnidirectional pattern.

The vertical radiation pattern for the lower UHF antenna in figure S-6 shows a 62° beamwidth at 300 MHz with some pattern distortion caused by the upper VHF antenna. Figure S-7 is the lower UHF horizontal radiation pattern which shows approximately 1 1/2 dB variation in its omnidirectional pattern at 225 MHz.

The gain of the D-2213 upper VHF antenna at 127 MHz and lower UHF antenna at 300 MHz measured 1 dB below the standard gain dipoles (-1 dBd or +1 dBi) as shown by the standard gain antenna dots on the horizontal radiation patterns.

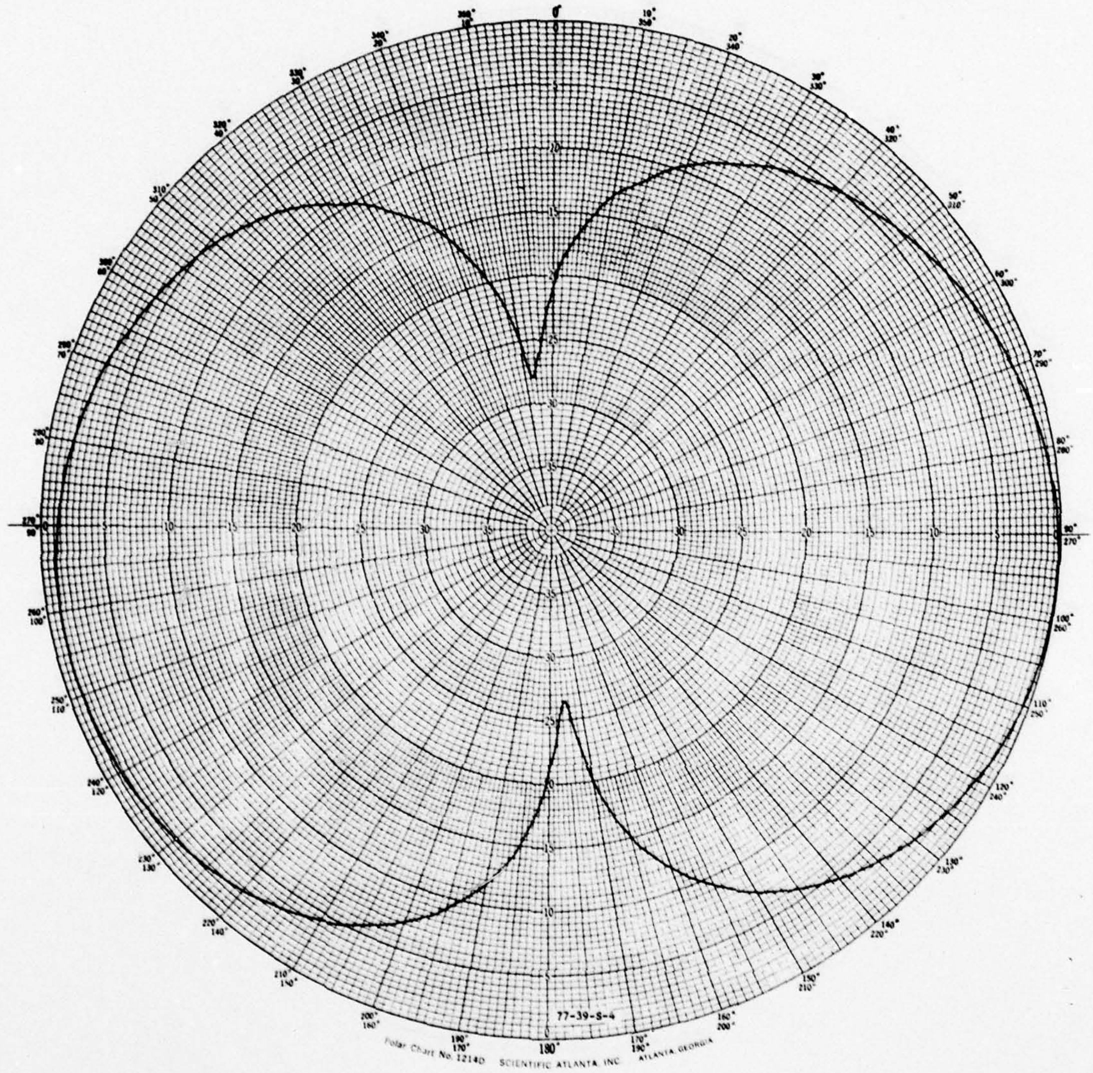


FIGURE S-4. D-2213 UPPER VHF VERTICAL RADIATION PATTERN

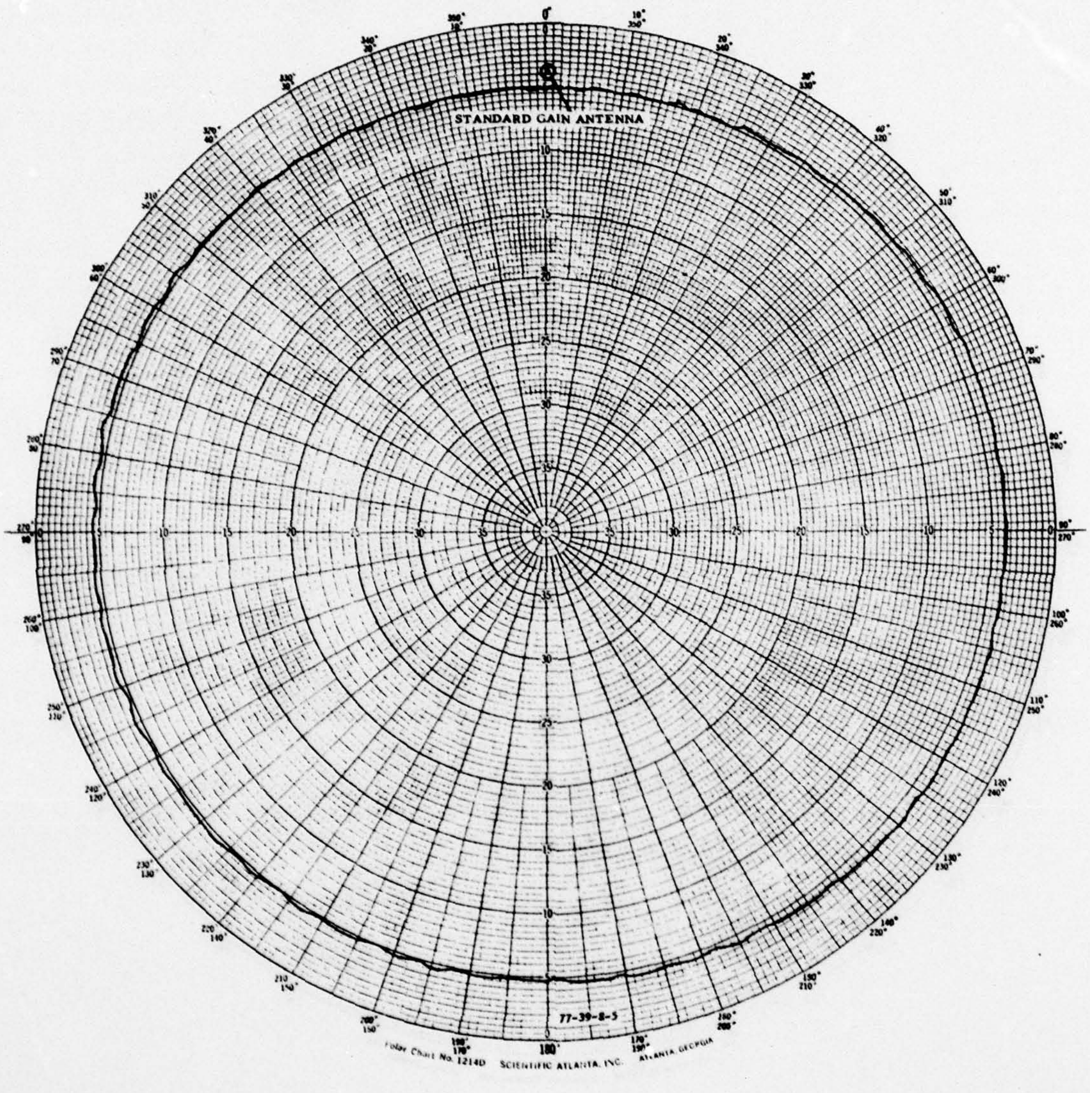


FIGURE S-5. D-2213 UPPER VHF HORIZONTAL RADIATION PATTERN

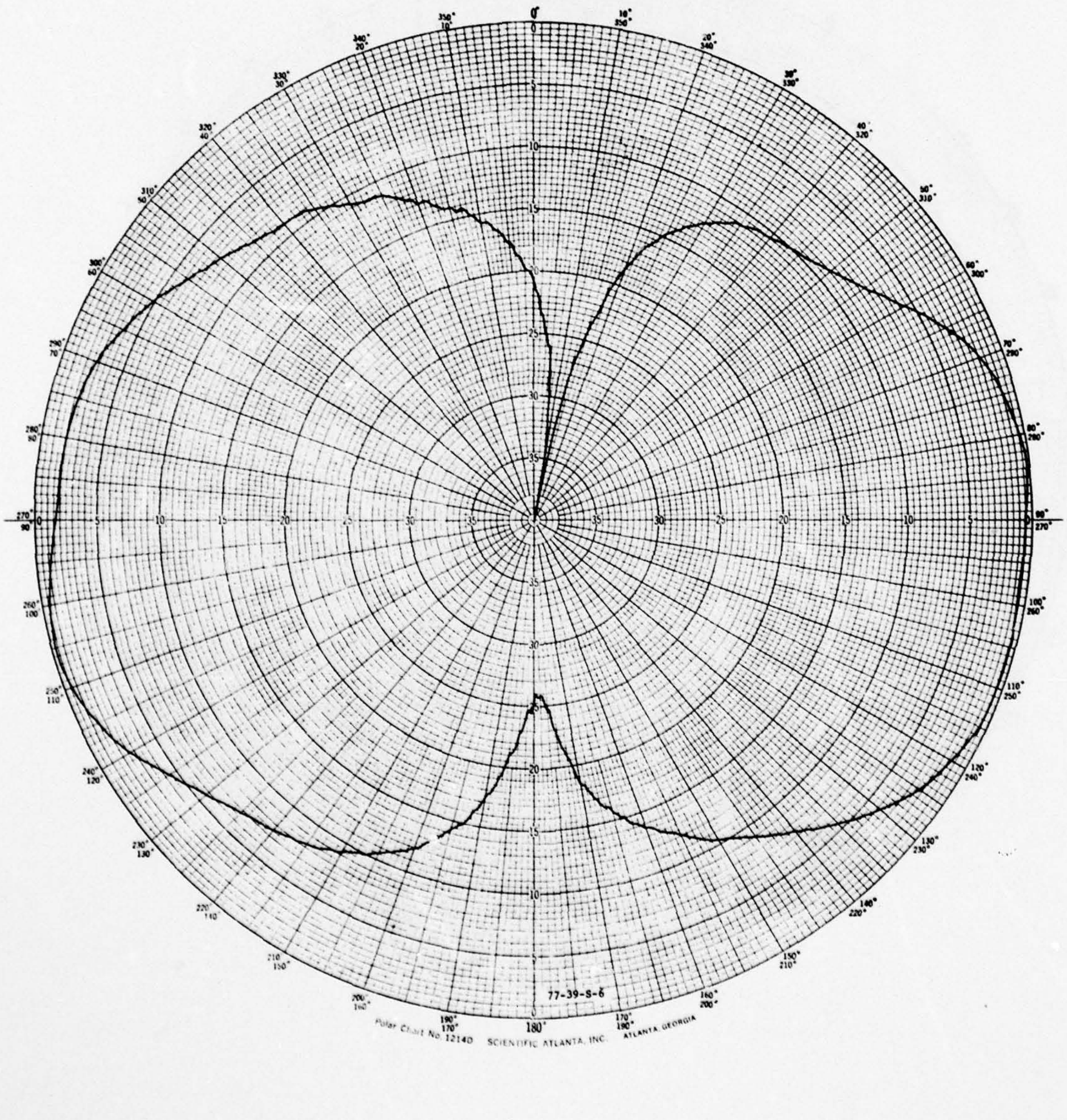
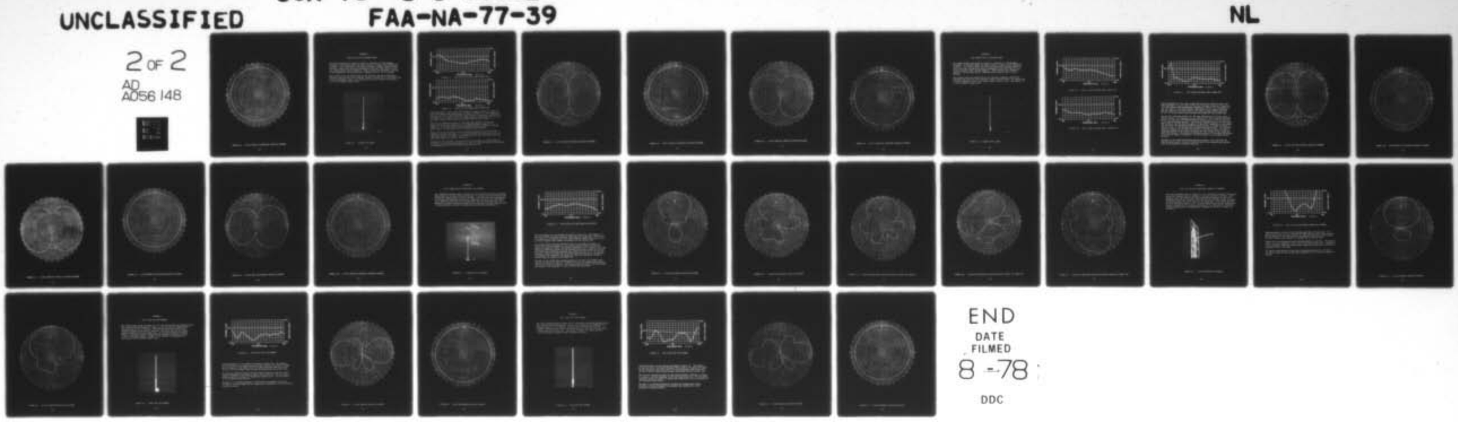


FIGURE S-6. D-2213 LOWER UHF VERTICAL RADIATION PATTERN

AD-A056 148 NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER ATL--ETC F/G 17/7
TEST AND EVALUATION OF AIR/GROUND COMMUNICATIONS ANTENNAS.(U)
JUN 78 J J COYLE

UNCLASSIFIED FAA-NA-77-39 NL

2 OF 2
AD A056 148



END
DATE
FILMED
8-78
DDC

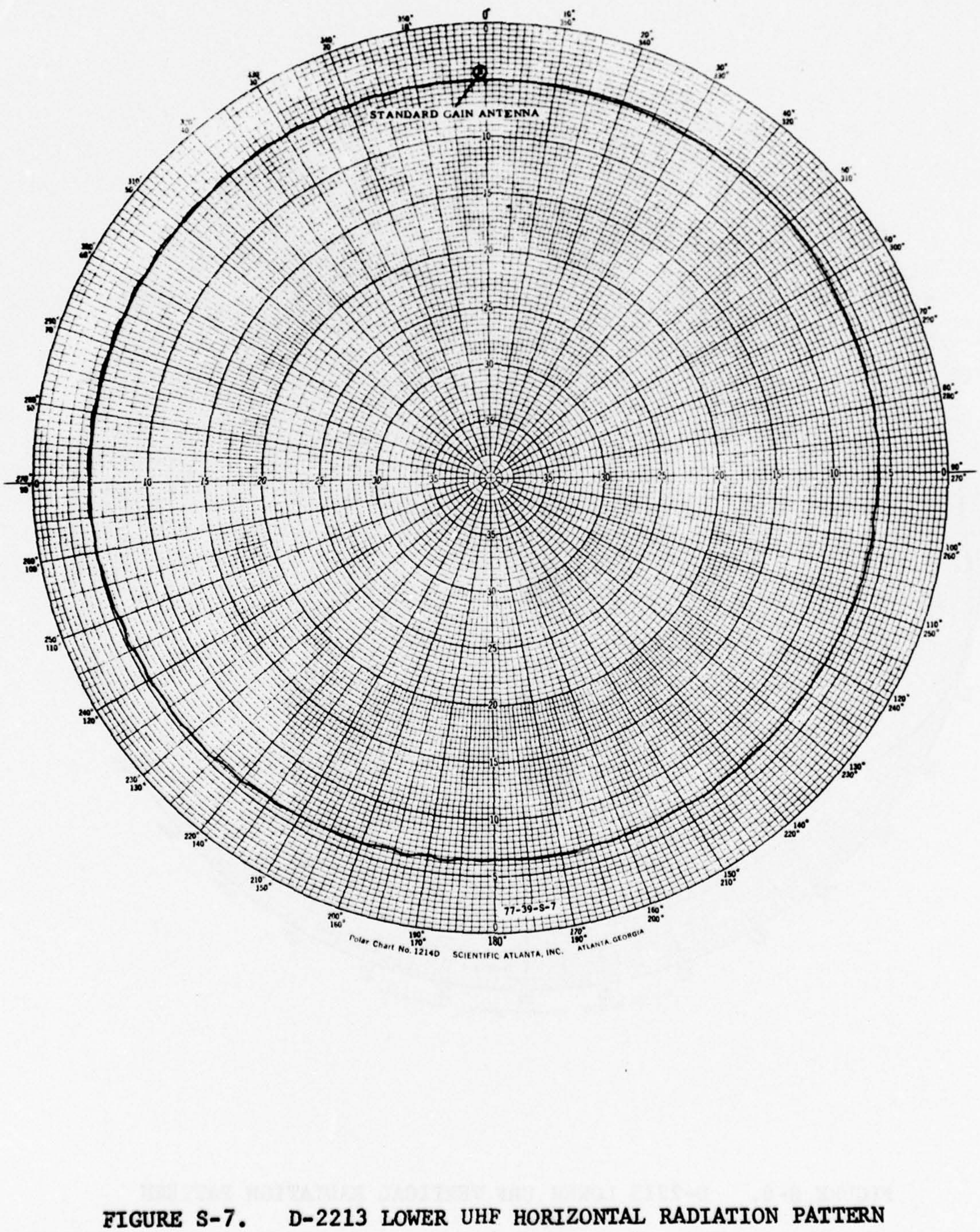


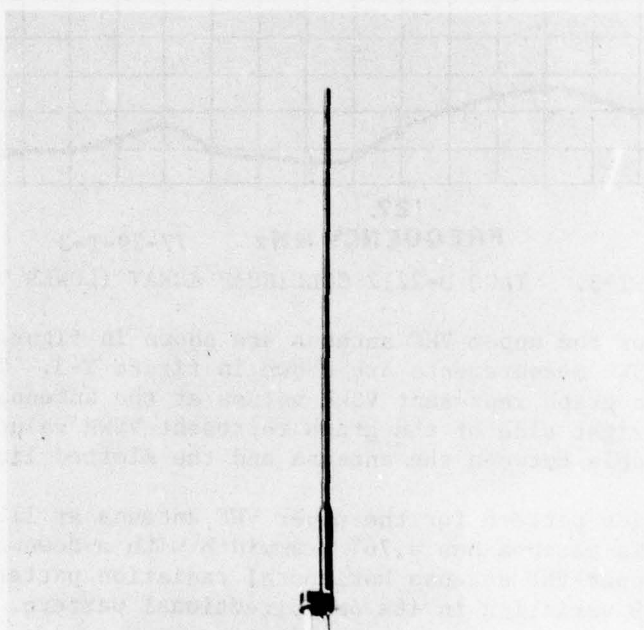
FIGURE S-7. D-2213 LOWER UHF HORIZONTAL RADIATION PATTERN

APPENDIX T

TACO D-2212 (V-V) COLLINEAR ARRAY

The D-2212 antenna array shown in figure T-1 consists of 2 VHF antennas arranged in a collinear manner and sealed inside a filament wound fiberglass enclosure. Both antennas are vertically polarized broadband omnidirectional half-wave dipoles that operated independently with more than 30 dB of isolation between their antenna elements. These antennas were designed to operate in the extended VHF A/G communications frequency band of 116 to 150 MHz.

This antenna array was manufactured by the Technical Appliance Corporation, Sherburne, New York and cost $1,030.00, weighs 15 pounds and is 152 inches long. A modled fiberglass clamp on the antenna base is used to mount this antenna on a 3-inch diameter support mast.



77-39-T-1

FIGURE T-1. D-2212 (V-V) ARRAY

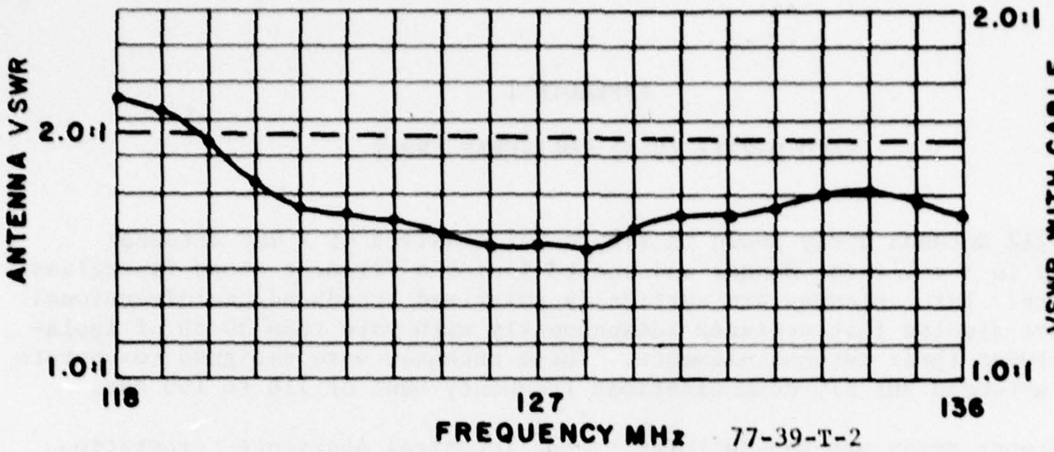


FIGURE T-2. TACO D-2212 COLLINEAR ARRAY (UPPER VHF)

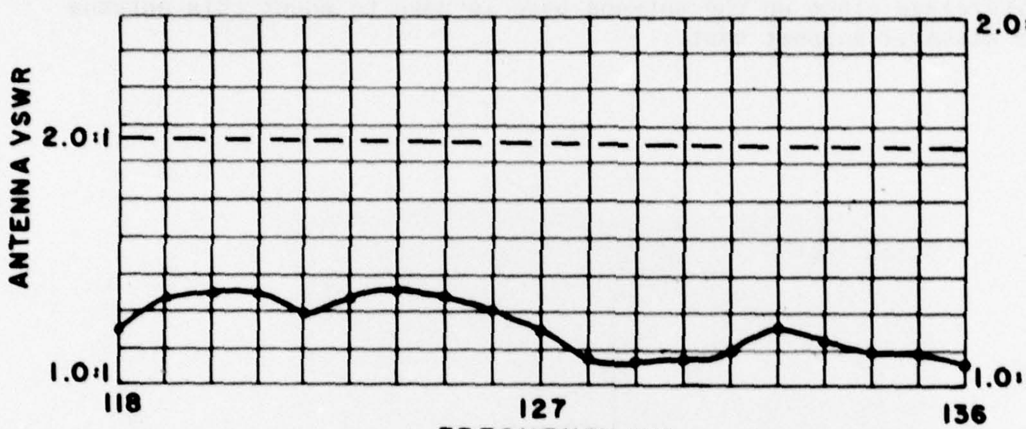


FIGURE T-3. TACO D-2212 COLLINEAR ARRAY (LOWER VHF)

VSWR measurements for the upper VHF antenna are shown in figure T-2 and the lower VHF antenna VSWR measurements are shown in figure T-3. The numbers on the left side of the graph represent VSWR values at the antenna terminals and the numbers on the right side of the graph represent VSWR values with 50 foot of RG-214 coaxial cable between the antenna and the slotted line.

The vertical radiation pattern for the upper VHF antenna at 118 MHz in figure T-4 shows this antenna has a 76° beamwidth with a downward tilt. Figure T-5 is the upper VHF antenna horizontal radiation pattern at 118 MHz which shows a 1/2 dB variation in its omnidirectional pattern.

Figure T-6 is the free-space vertical radiation pattern for the lower VHF antenna at 118 MHz and figure T-7 is the horizontal radiation pattern for the lower VHF antenna at 118 MHz. The 118 MHz patterns were selected to show the worst-case pattern distortion conditions.

The gain of both the upper and lower D-2212 VHF antennas at 127 MHz measured 1 dB below the standard gain antennas (-1 dBd or +1 dBi) as shown by the standard gain antenna dots on the horizontal radiation patterns.

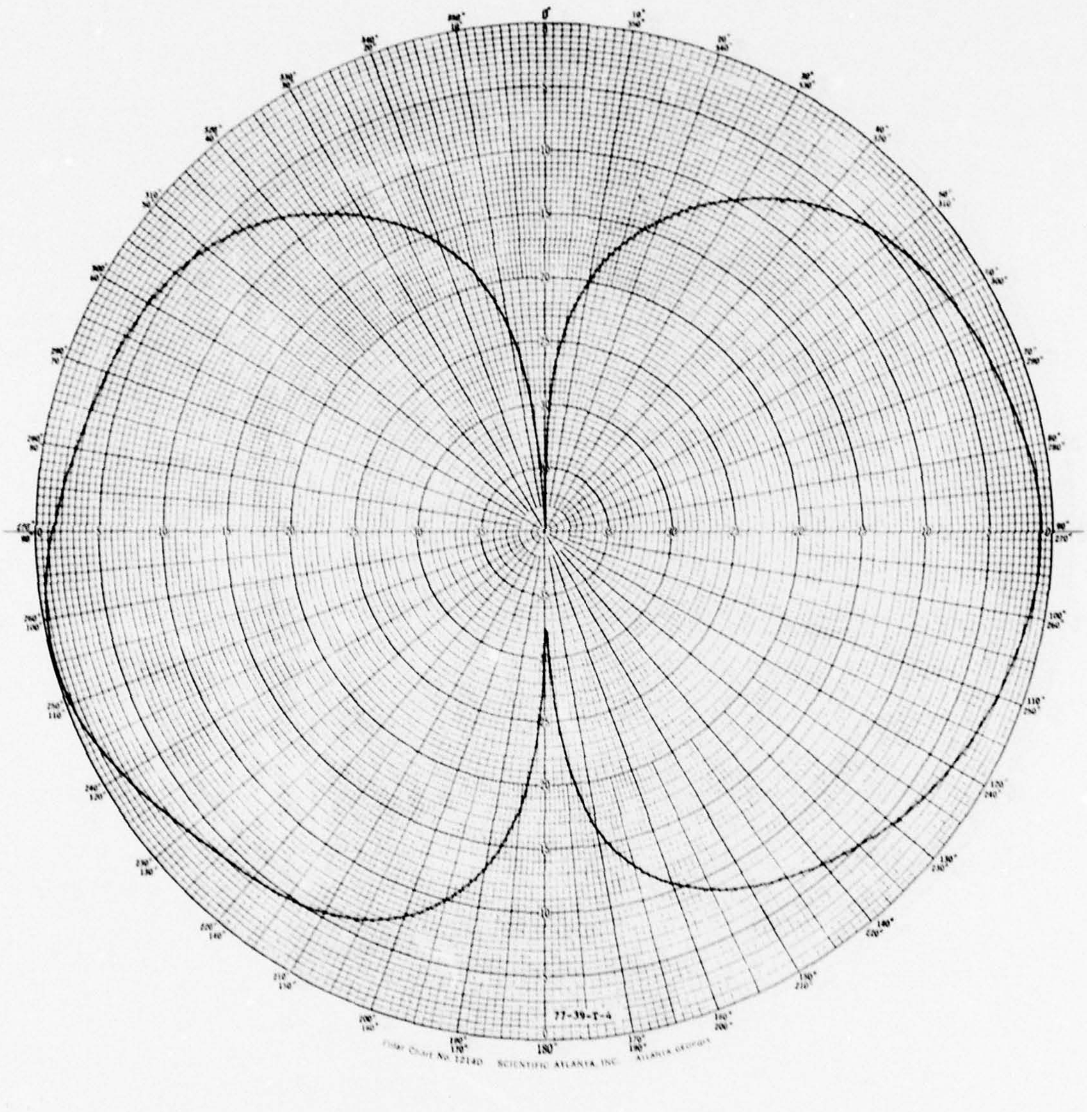


FIGURE T-4. D-2212 UPPER VHF VERTICAL RADIATION PATTERN

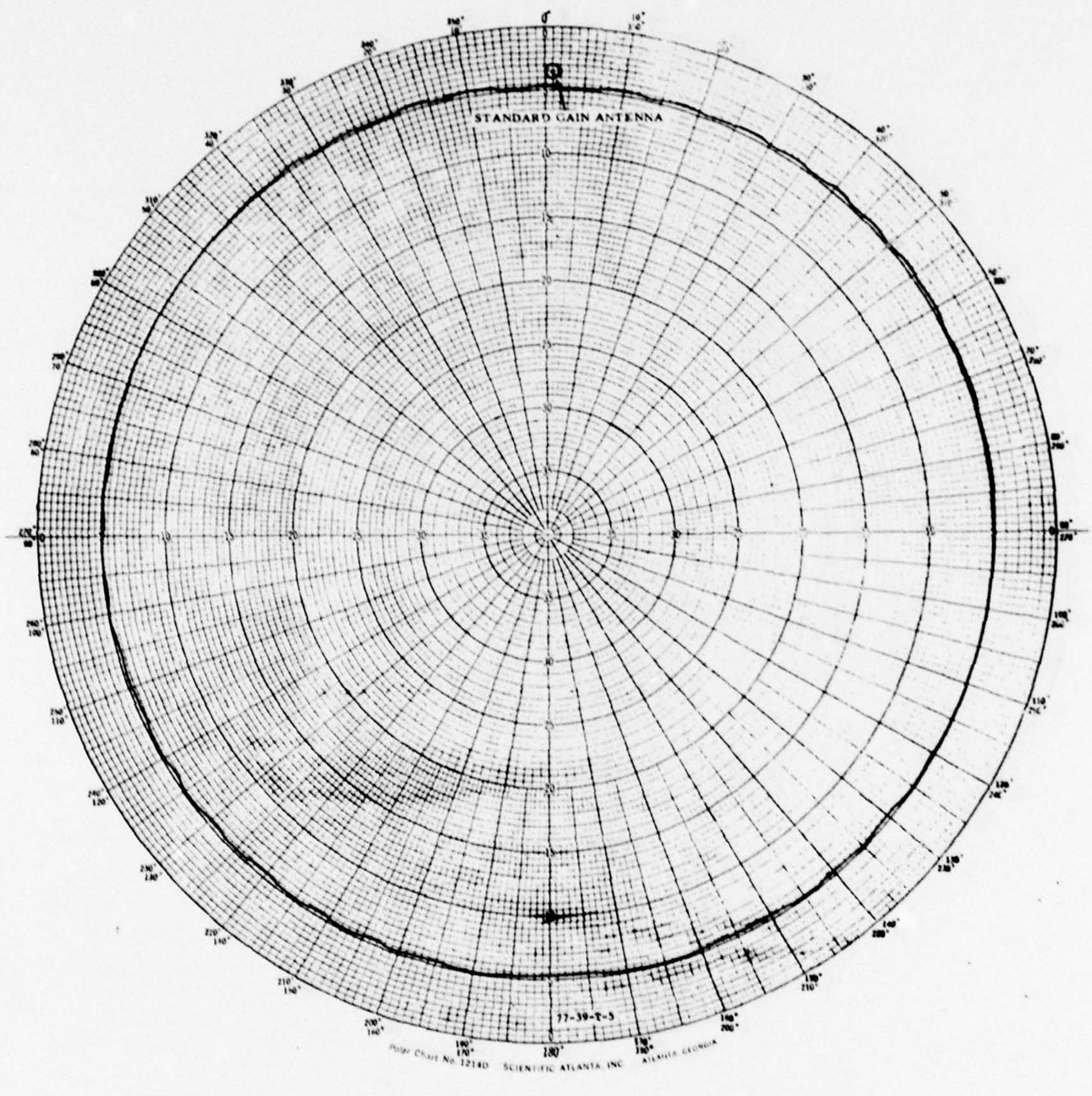


FIGURE T-5. D-2212 UPPER VHF HORIZONTAL RADIATION PATTERN

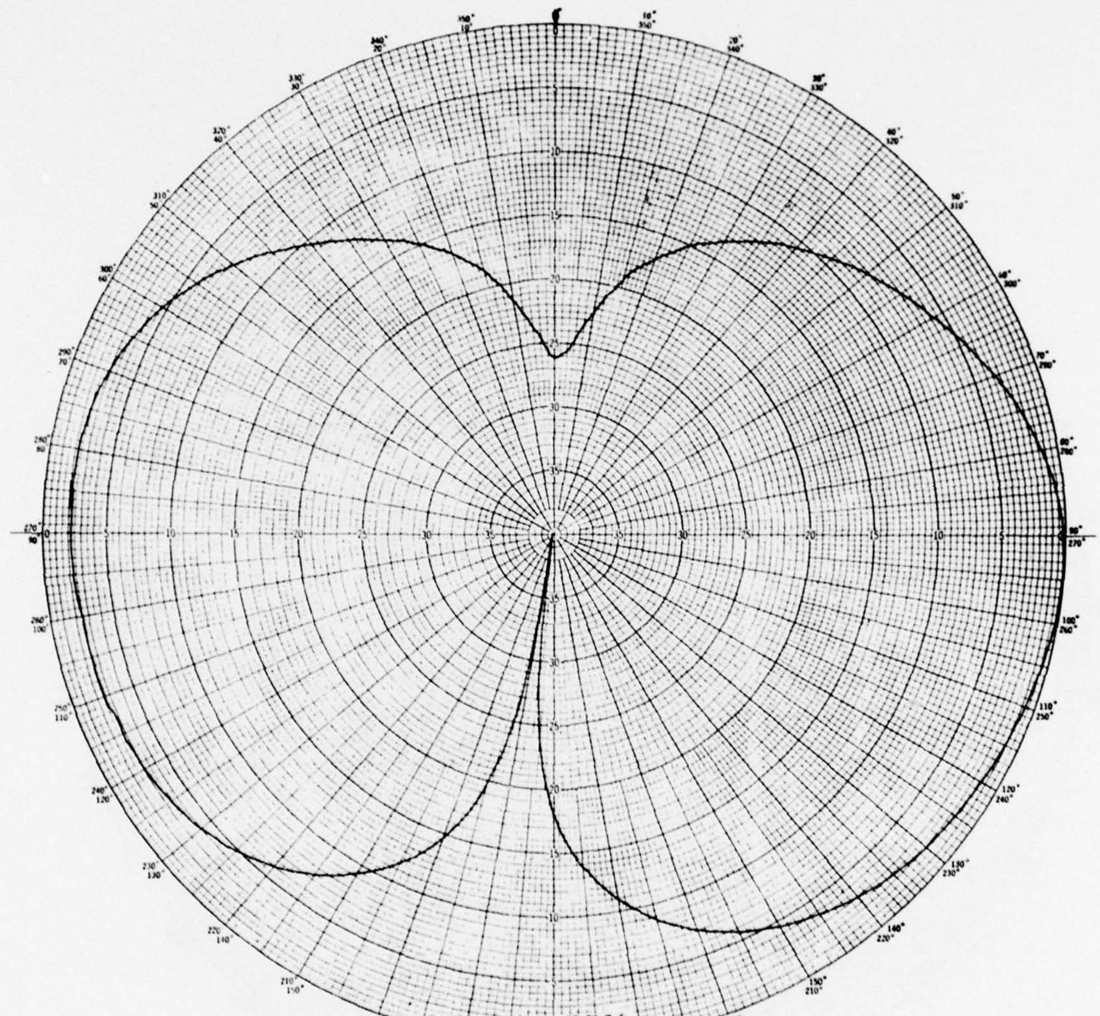


FIGURE T-6. D-2212 LOWER VHF VERTICAL RADIATION PATTERN

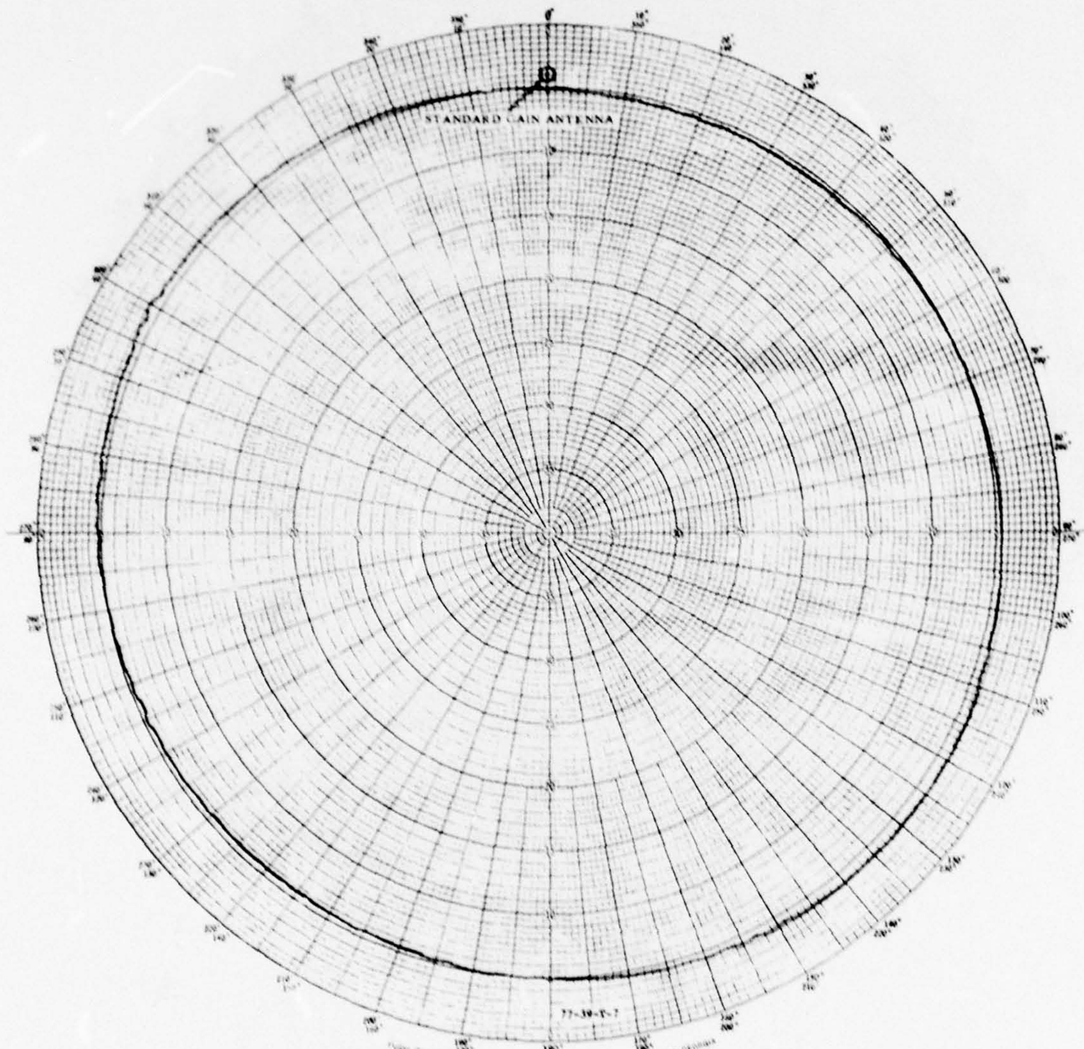


FIGURE T-7. D-2212 LOWER VHF HORIZONTAL RADIATION PATTERN

APPENDIX U

TACO D-2260 (V-V-V) COLLINEAR ARRAY

The D-2260 antenna array shown in figure U-1 consists of 3 VHF antennas arranged in a collinear manner and sealed inside a filament wound fiberglass enclosure. All three antennas are vertically polarized broadband omnidirectional half-wave dipoles that operate independently with more than 30 dB of isolation between their antenna elements. These antennas were designed to operate in the extended VHF A/G communications frequency band of 116 to 150 MHz.

This antenna array was manufacturd by the Technical Appliance Corporation, Sherburne, New York and cost $1,405.00, weighs 19 pounds and is 196 inches long. A molded fiberglass clamp on the antenna base is used to mount this antenna on a 3-inch diameter support mast.

77-39-U-1

FIGURE U-1. D-2260 (V-V-V) ARRAY

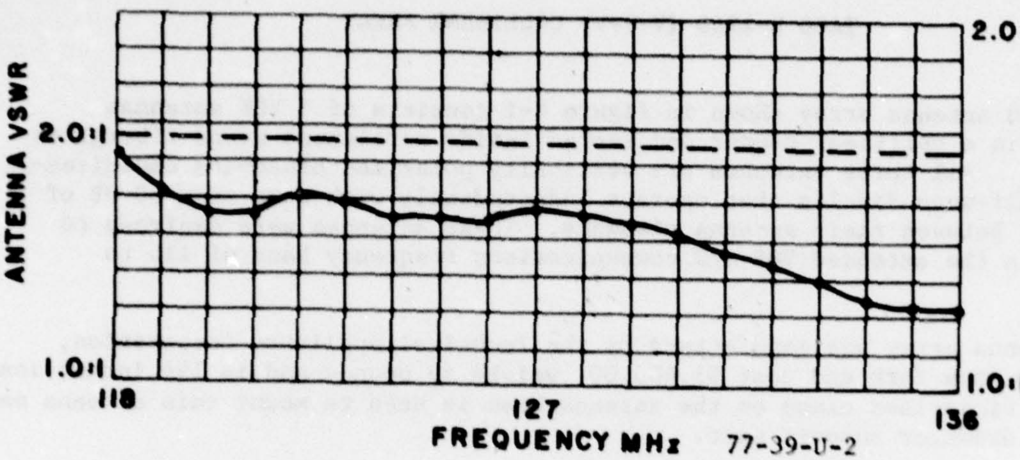


FIGURE U-2. TACO D-2260 COLLINEAR ARRAY (UPPER VHF)

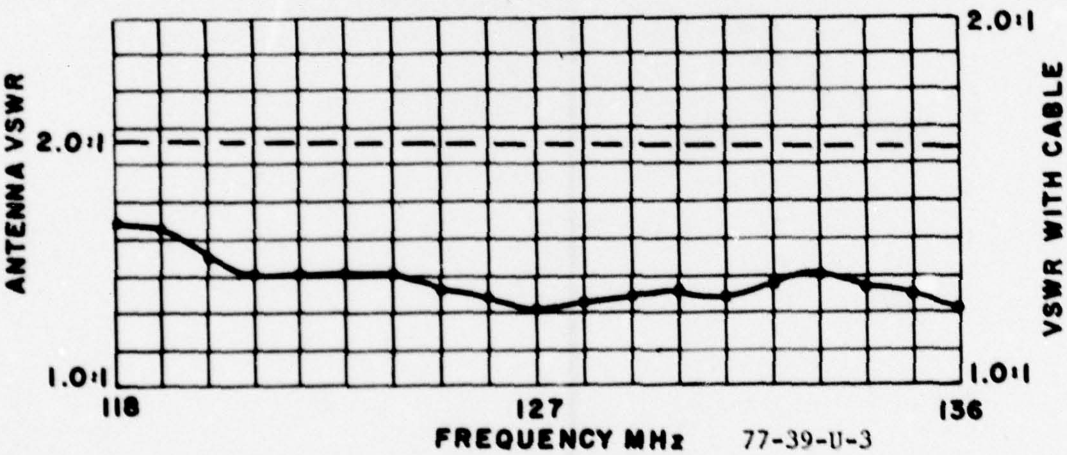


FIGURE U-3. TACO D-2260 COLLINEAR ARRAY (CENTER VHF)

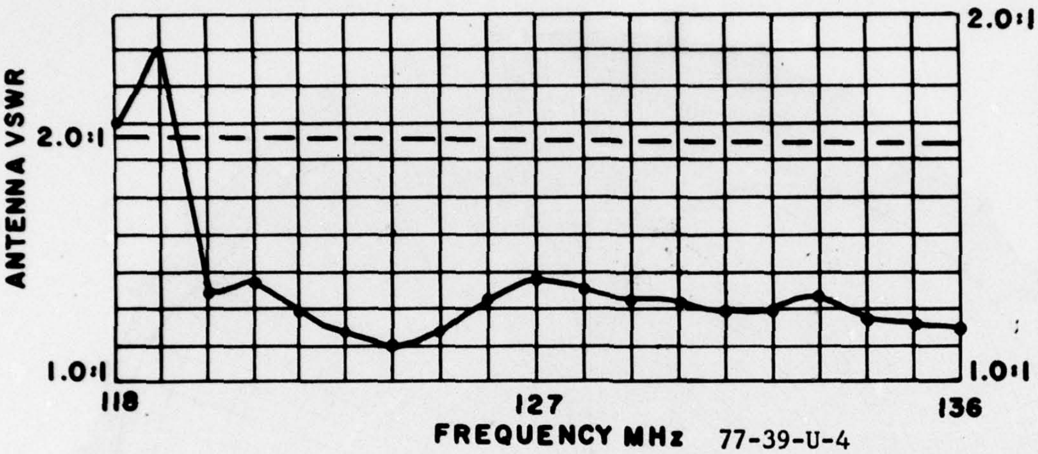


FIGURE U-4. TACO D-2260 COLLINEAR ARRAY (LOWER VHF)

VSWR measurements for the upper D-2260 VHF antenna are shown in figure U-2. VSWR measurement for the center VHF antenna are shown in figure U-3, and the lower VHF antenna VSWR measurements are shown in figure U-4. The numbers on the left side of the graph represent VSWR values at the antenna terminals and the numbers on the right side of the graph represent VSWR values with 50 foot of RG-214 coaxial cable between the antenna and the slotted line.

The vertical radiation pattern for the upper VHF antenna at 127 MHz shown in figure U-5 has a 92° beamwidth with an upward tilt. The horizontal radiation pattern for the upper VHF antenna shown in figure U-6 has a 1/2 dB variation in its omnidirectional pattern. The vertical radiation pattern for the center VHF antenna at 127 MHz shown in figure U-7 has an 83° beamwidth on the horizon and the center VHF antenna horizonal radation pattern at 127 MHz as shown in figure U-8 has a 1 dB variation in its omnidirectional pattern. The vertical radiation pattern for the lower VHF antenna at 127 MHz in figure U-9 shows a distorted pattern which could be caused by the feed cables to the center and upper VHF antennas. The horizontal radiation pattern for the lower VHF antenna at 127 MHz in figure U-10 shows a 1 1/2 dB variation in its omnidirectional pattern.

The gain of the D-2260 VHF antennas measured between 1 and 2 dB below the standard gain dipole (-2 dBd or 0 dBi) as shown by the standard gain antenna dots on the horizontal radiation patterns.

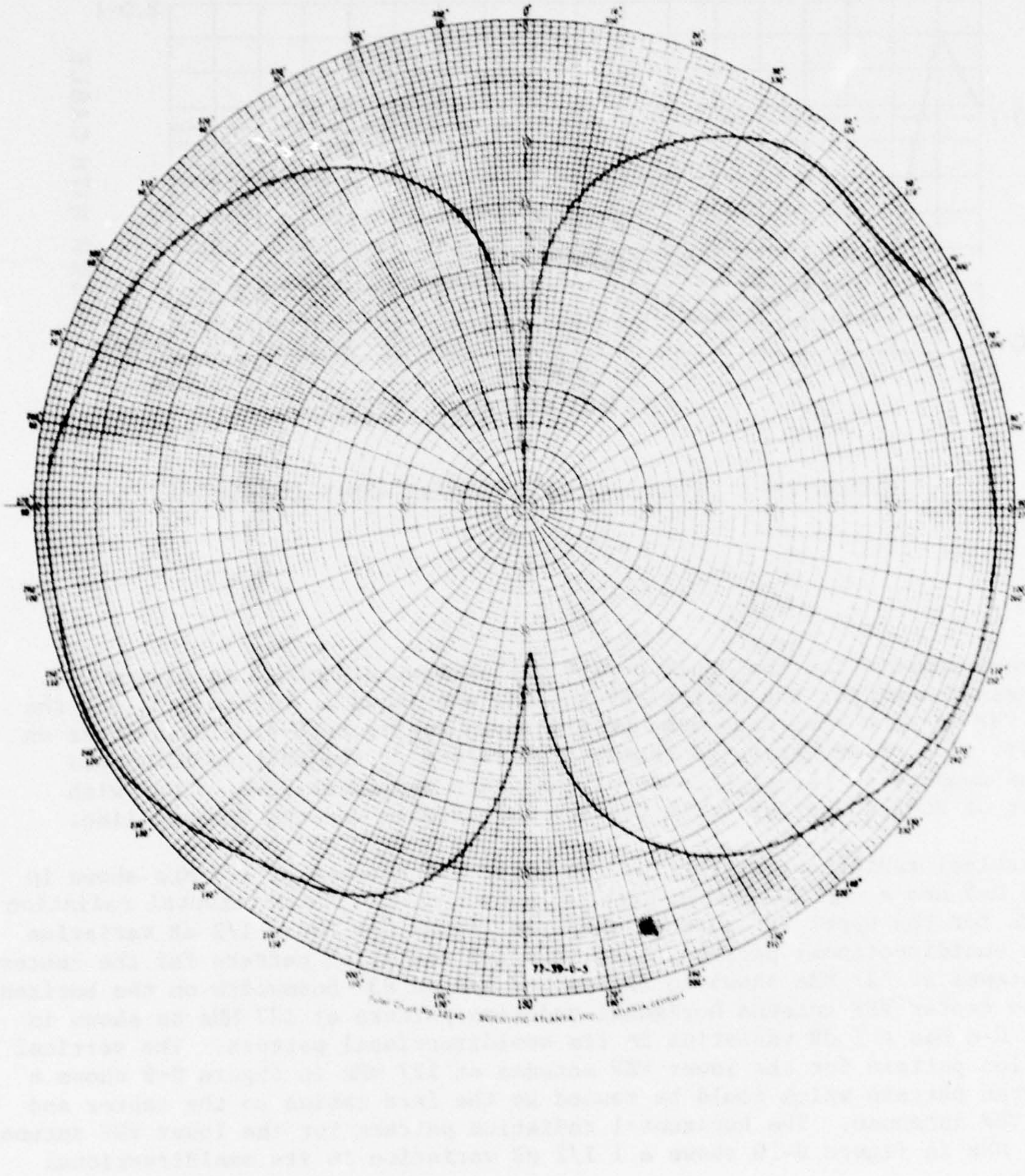


FIGURE U-5. D-2260 UPPER VHF VERTICAL RADIATION PATTERN

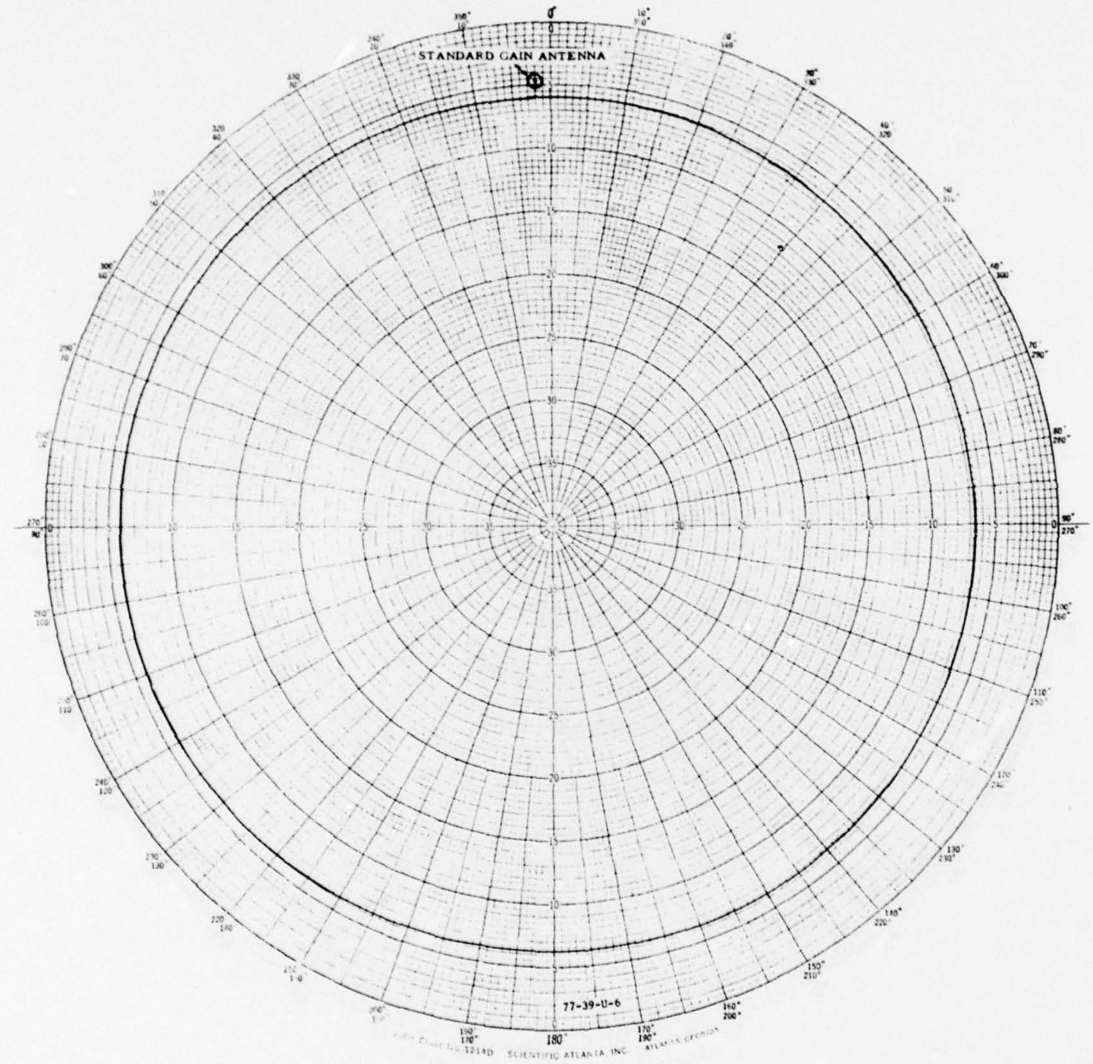


FIGURE U-6. D-2260 UPPER VHF HORIZONTAL RADIATION PATTERN

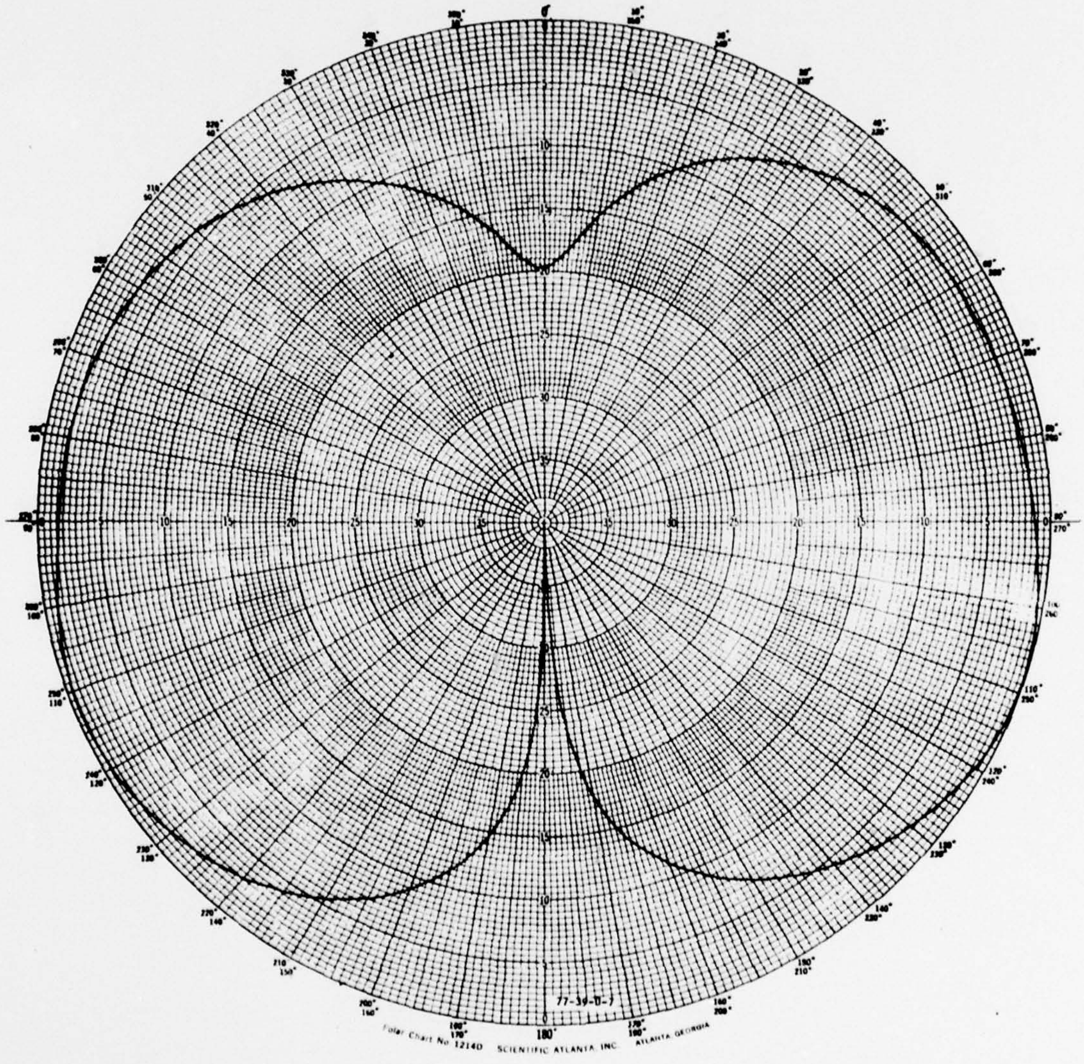


FIGURE U-7. D-2260 CENTER VHF VERTICAL RADIATION PATTERN

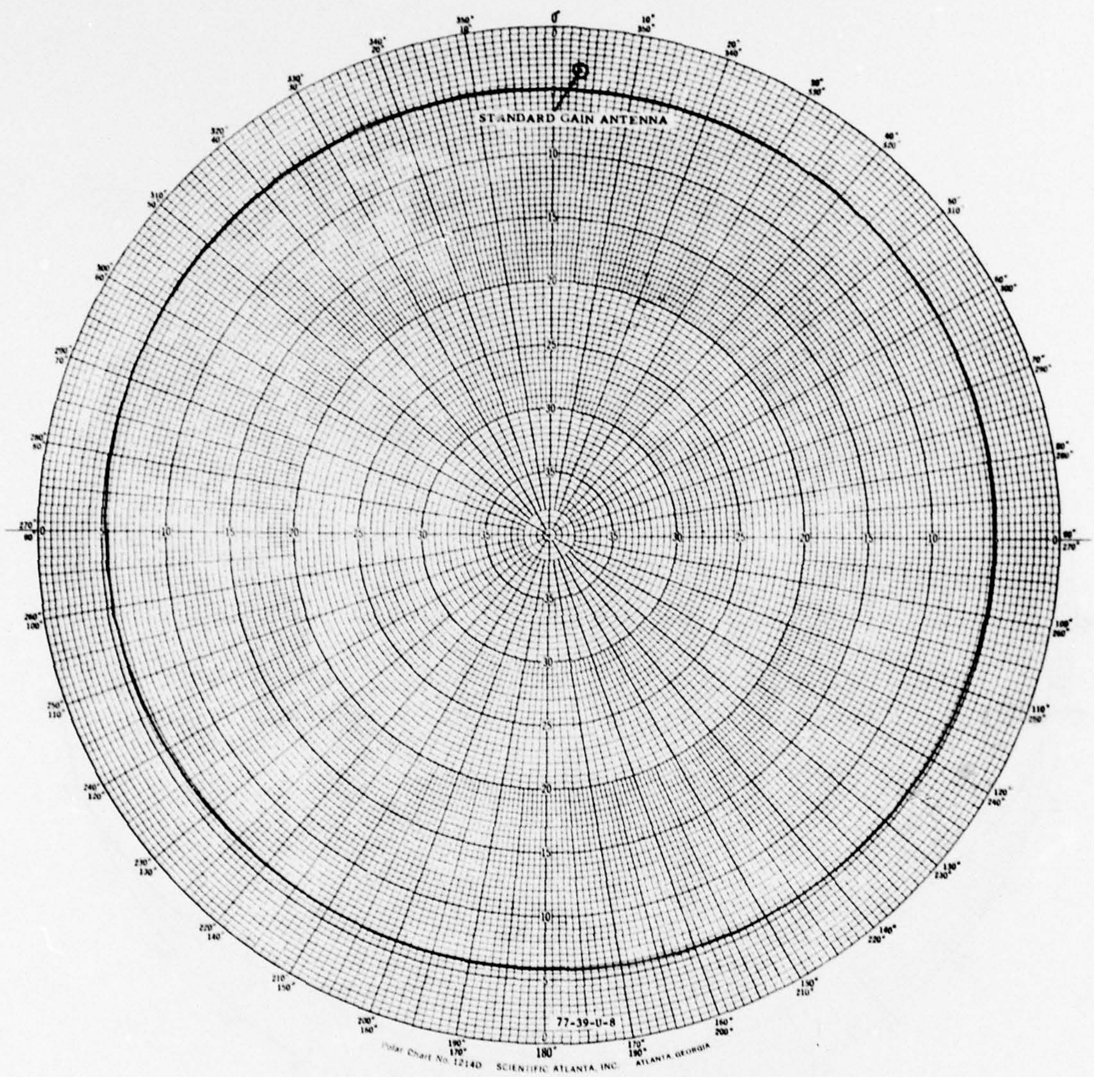


FIGURE U-8. D-2260 CENTER VHF HORIZONTAL RADIATION PATTERN

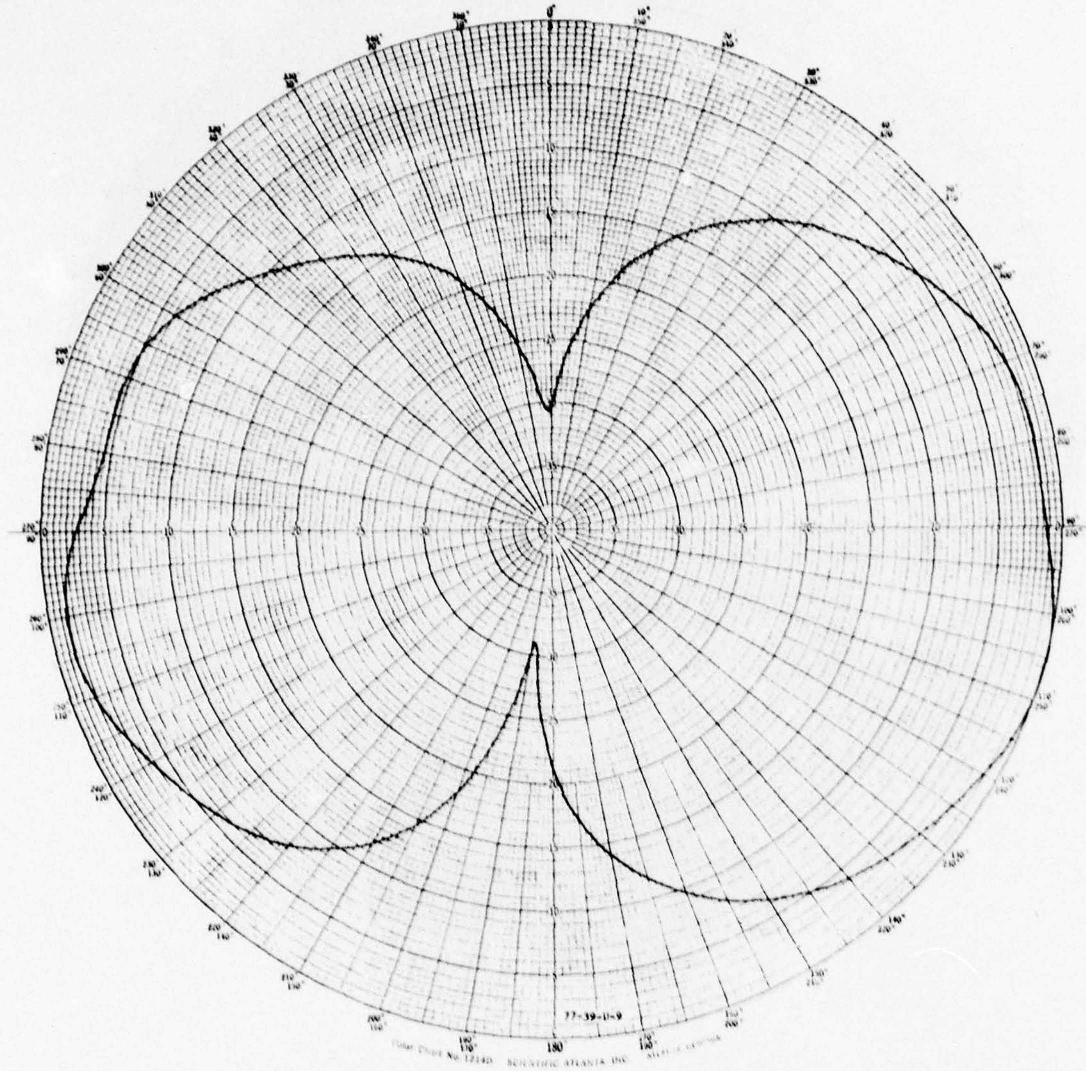


FIGURE U-9. D-2260 LOWER VHF VERTICAL RADIATION PATTERN

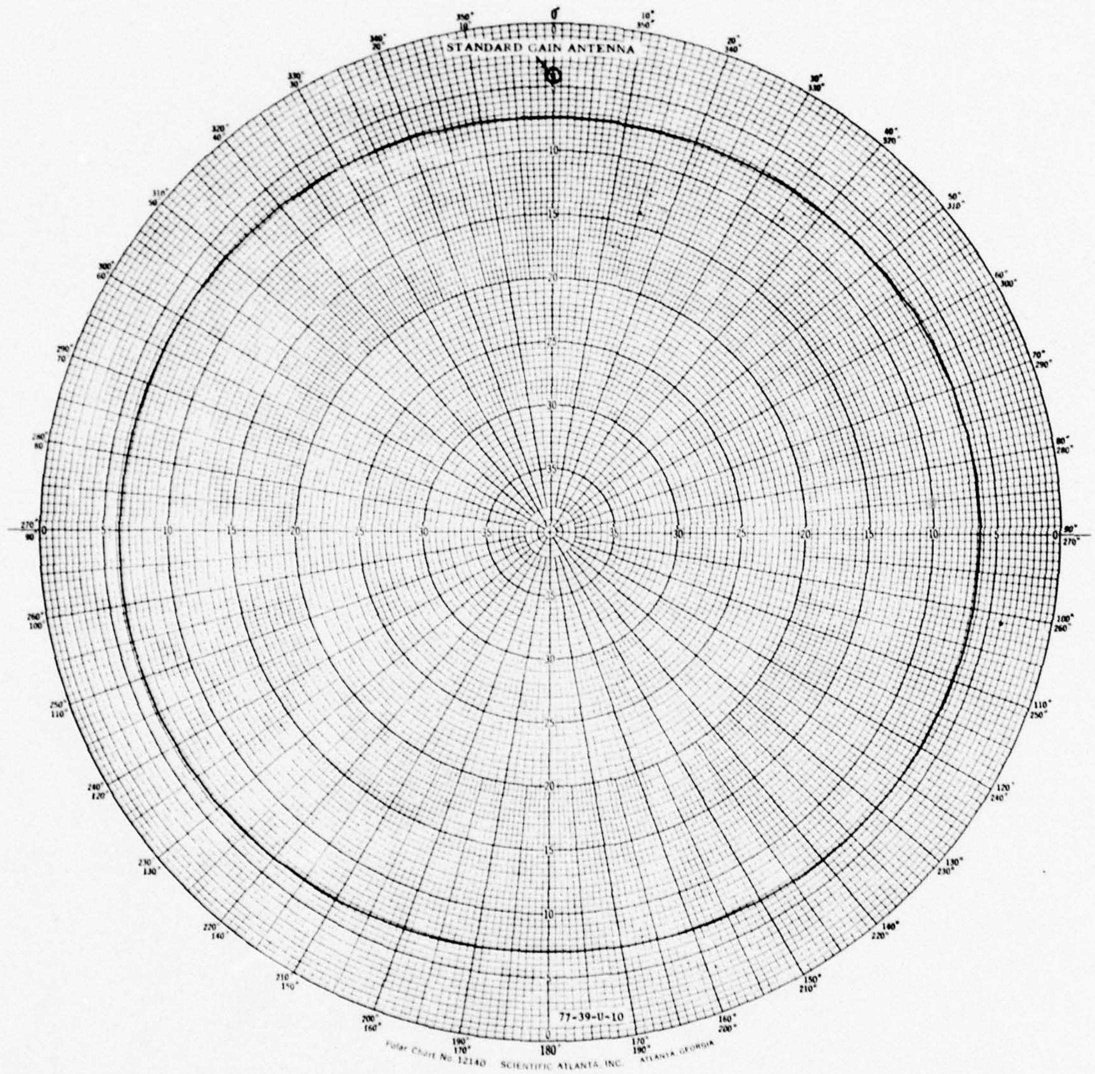


FIGURE U-10. D-2260 LOWER VHF HORIZONTAL RADIATION PATTERN

APPENDIX V

TACO Y-102B-130 VHF DIRECTIONAL YAGI ANTENNA

The Y-102B-130 antennas shown in figure V-1 are vertically polarized 10-element directional YAGI antennas that were designed to operate across the VHF A/G communication frequency band of 118 to 136 MHz. These antennas were manufactured by the Technical Appliance Corporation, Sherburne, New York, and cost $202.00 each, weigh 12 pounds each and are 103-inches long and 50 inches high. The antennas are shown vertically stacked 10 feet apart and connected together with a stacking harness to permit increased gain and skewing measurements.

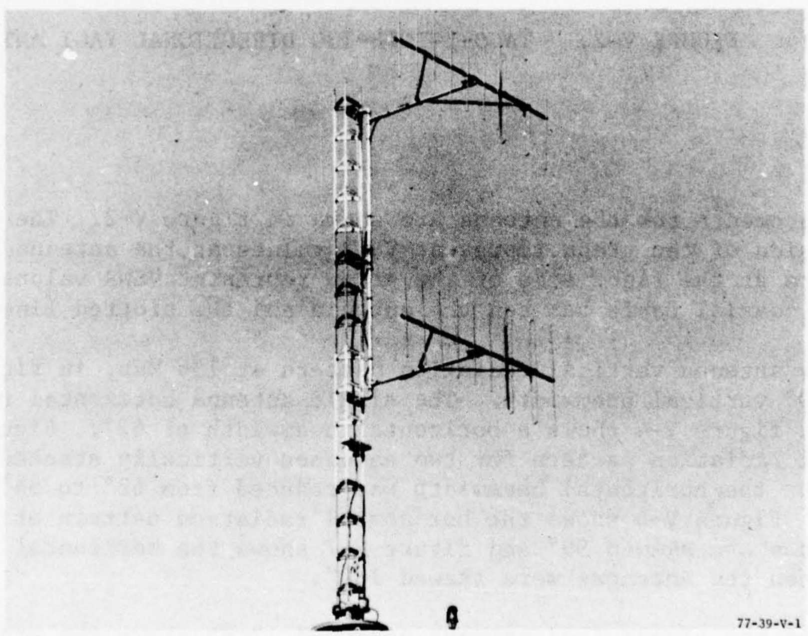


FIGURE V-1. Y-102B-130 YAGI ANTENNAS

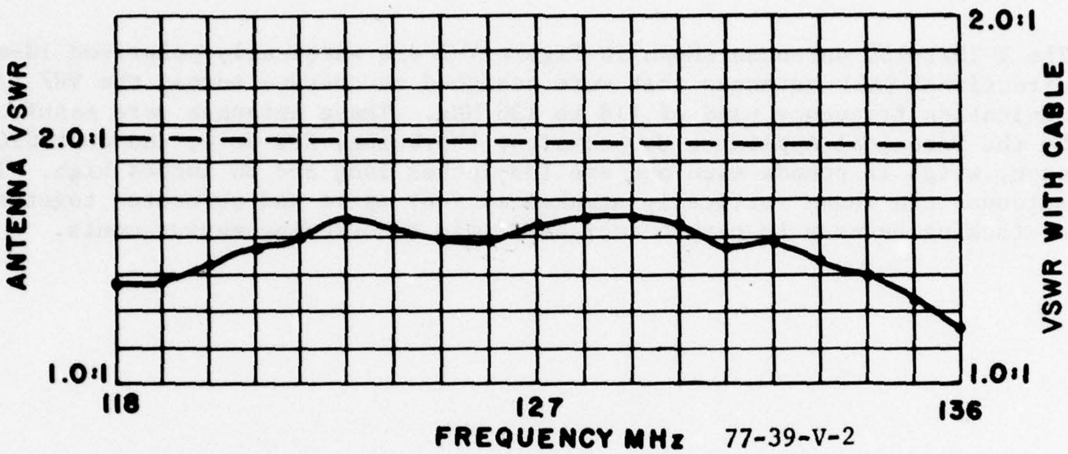


FIGURE V-2. TACO-Y-102B-130 DIRECTIONAL YAGI ANTENNA

VSWR measurements for the antenna are shown in figure V-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers at the right side of the graph represent VSWR values with 50 foot of RG-214 coaxial cable between the antenna and the slotted line.

The single antenna vertical radiation pattern at 136 MHz, in figure V-3, shows a 50° vertical beamwidth. The single antenna horizontal radiation pattern in figure V-4 shows a horizontal beamwidth of 62°. Figure V-5 is the horizontal radiation pattern for two antennas vertically stacked and skewed 0° which shows the horizontal beamwidth was reduced from 62° to 54° by vertical stacking. Figure V-6 shows the horizontal radiation pattern at 136 MHz when the antennas are skewed 90° and figure V-7 shows the horizontal radiation pattern when the antennas were skewed 180°.

The gain of the single Yagi antenna measured 12 dB above the standard gain dipole (+12 dBd or +14 dBi) at 136 MHz as shown by the standard gain antenna dots on the radiation patterns. The antenna gains increased 3 dB when stacked and skewed 0° and decreased 3 dB when stacked and skewed 180°.

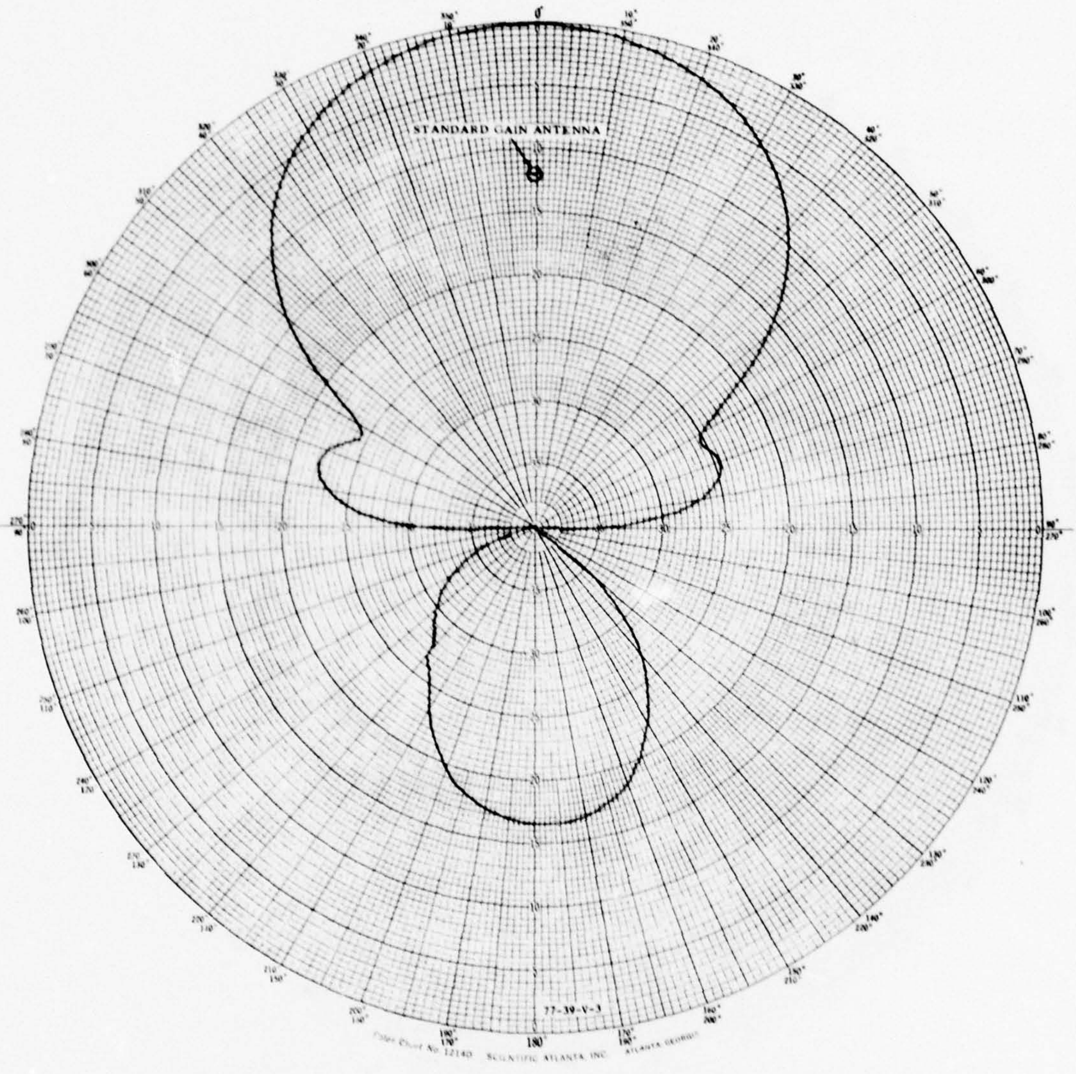


FIGURE V-3. Y-102B-130 VERTICAL RADIATION PATTERN

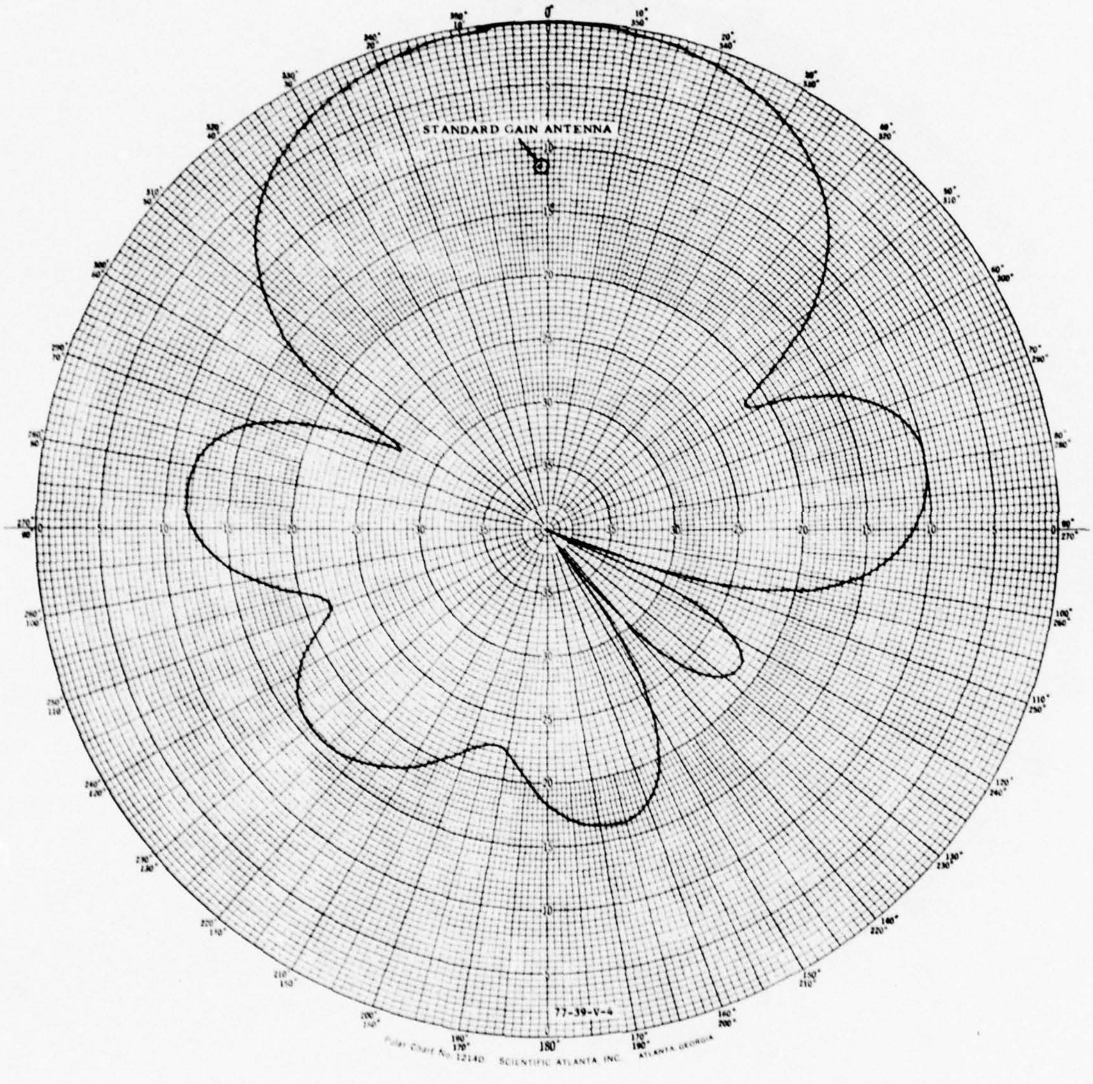


FIGURE V-4. Y-102B-130 HORIZONTAL RADIATION PATTERN

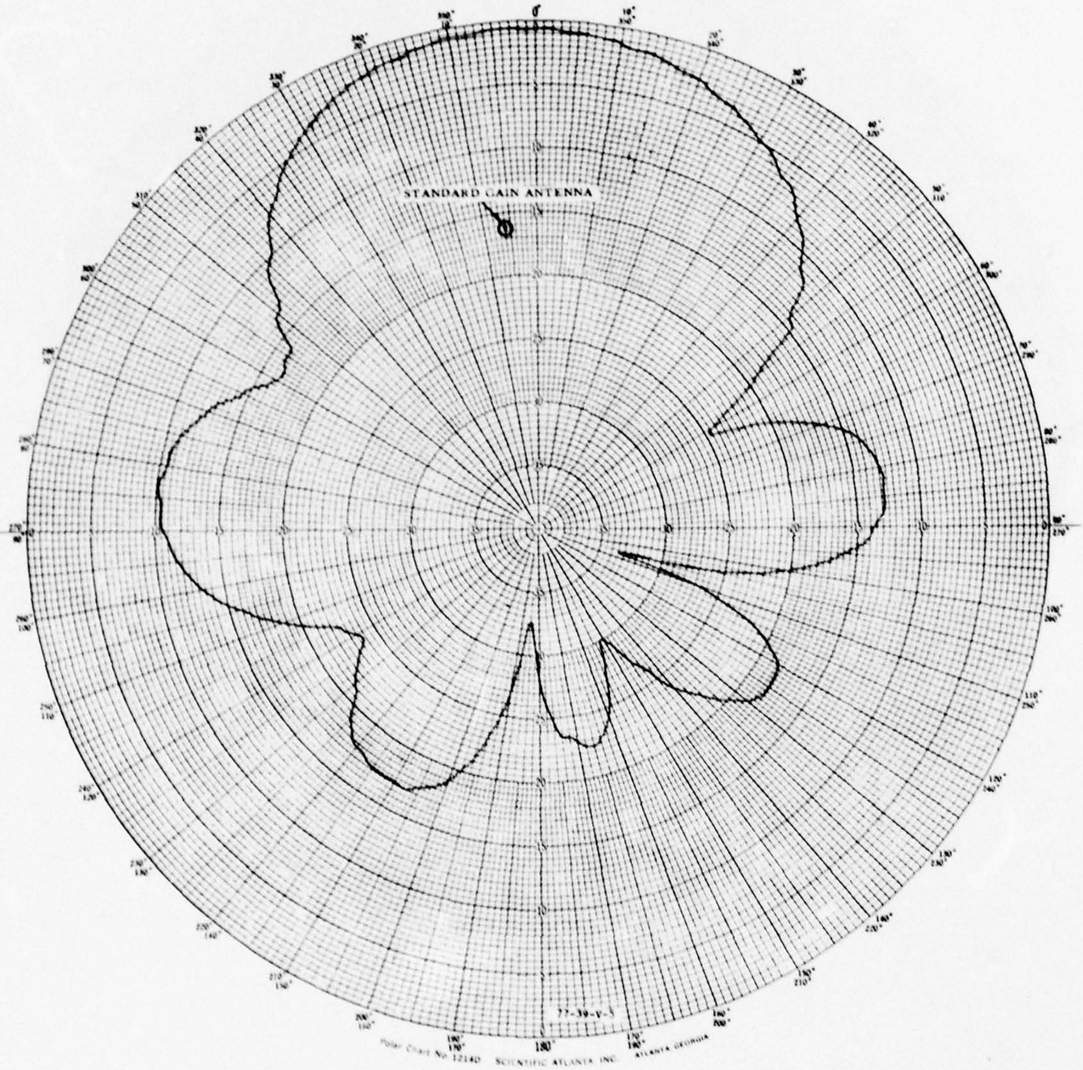


FIGURE V-5.   Y-102B-130 HORIZONTAL RADIATION PATTERN STACKED AND SKEWED 0°

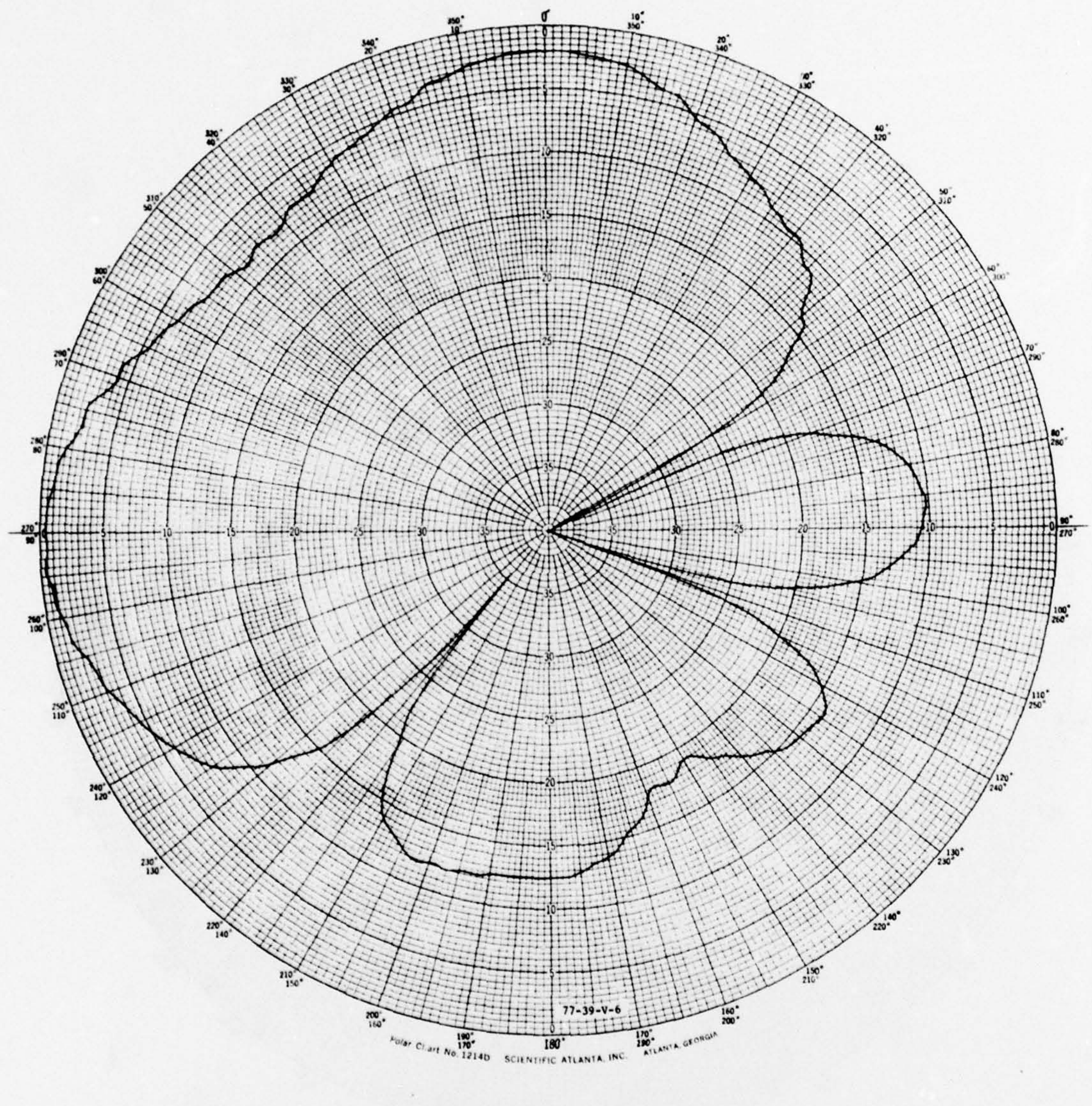


FIGURE V-6. Y-102B-130 HORIZONTAL RADIATION PATTERN STACKED AND SKEWED 90°

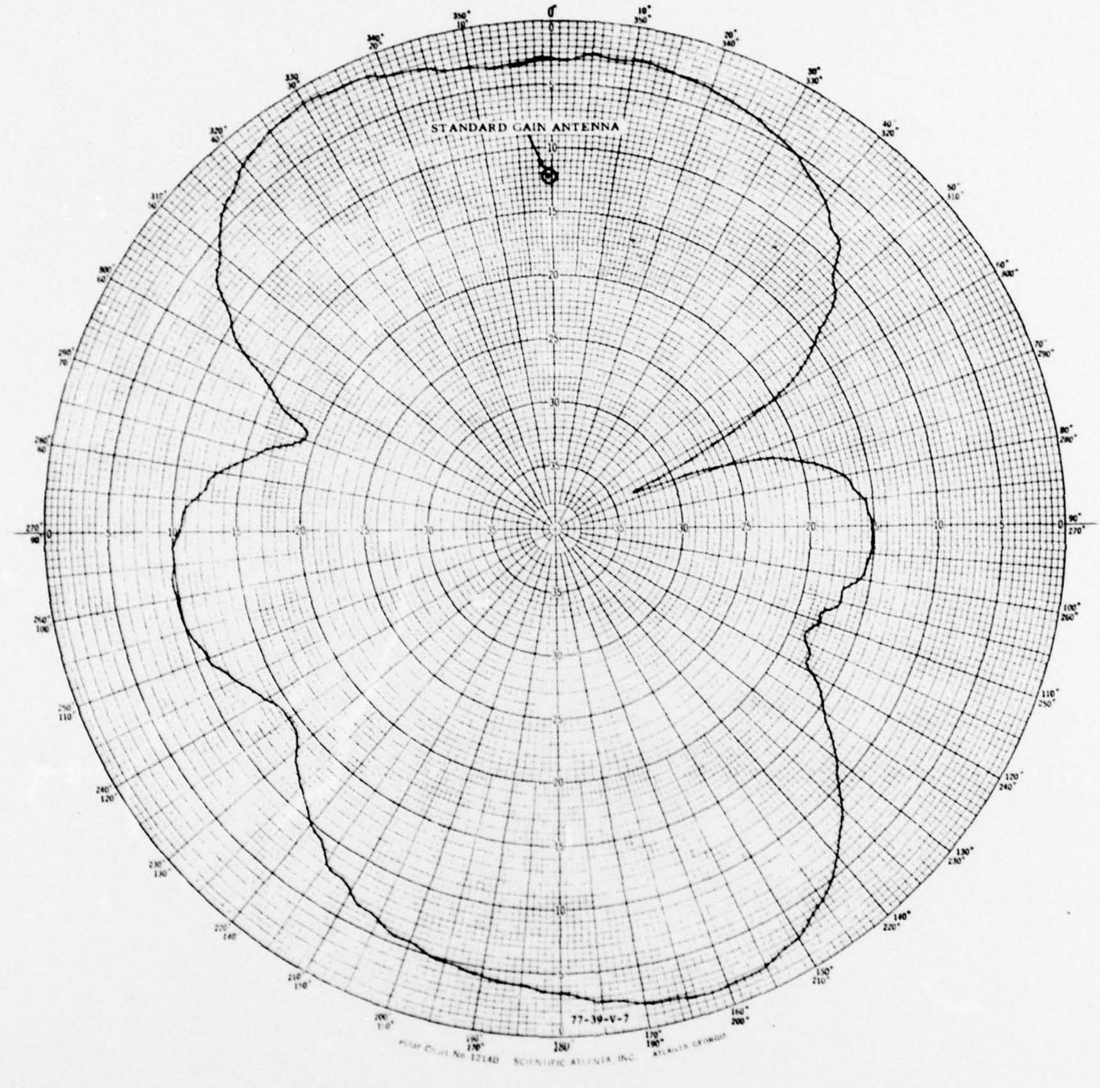


FIGURE V-7. Y-102B-130 HORIZONTAL RADIATION PATTERN STACKED AND SKEWED 180°

APPENDIX W

TACO Y-41-129 VHF DIRECTIONAL SCREEN YAGI ANTENNA

The Y-41-129 antenna shown in figure W-1 is a vertically polarized, directional screen YAGI antenna that was designed to operate from 126 to 132 MHz. This high gain grid type screen YAGI antenna was manufactured by the Technical Appliance Corporation, Sherburne, New York and cost $400.00, weighs 18 pounds, is 40 inches wide, 80 inches high, and 43 inches long. The antenna elements and grid tubing are welded to a 1 1/4 inch aluminum frame and the antenna feed system is foam-filled for reliable operation in all type weather conditions. Antenna installation is accomplished by clamping the frame to a supporting structure.

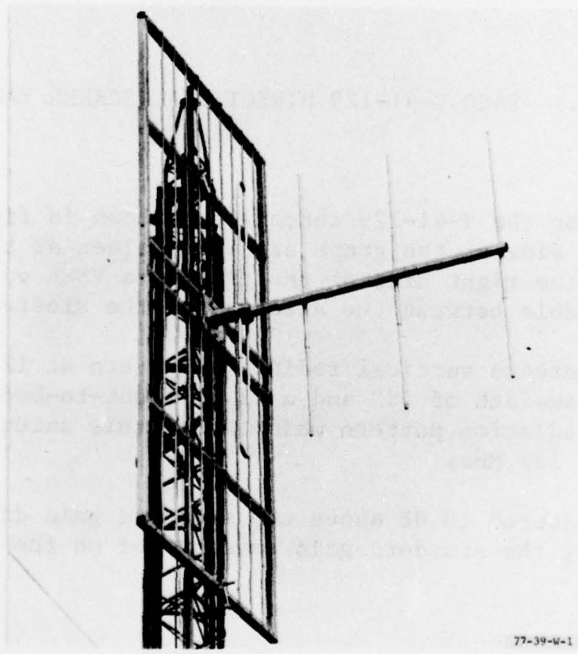


FIGURE W-1. Y-41-129 SCREEN YAGI ANTENNA

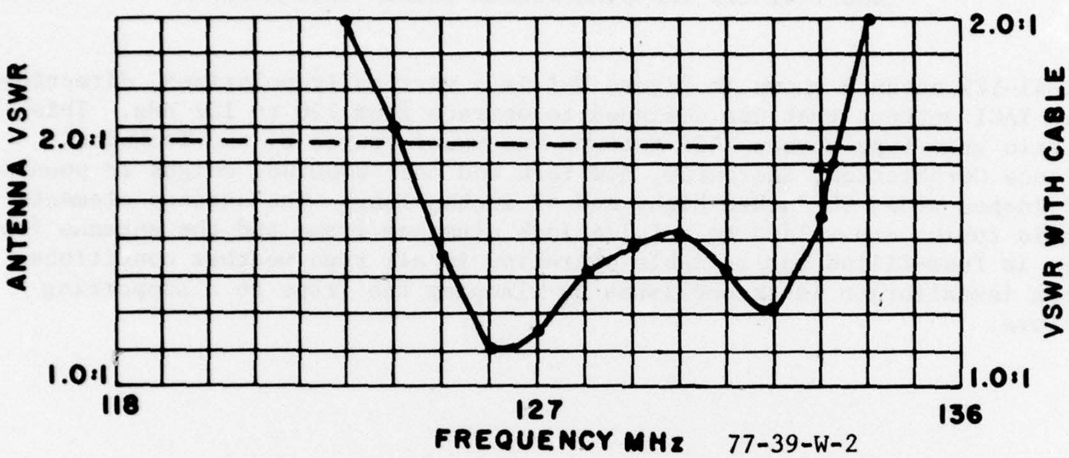


FIGURE W-2. TACO Y-41-129 DIRECTIONAL SCREEN YAGI ANTENNA

VSWR measurements for the Y-41-129 antenna are shown in figure W-2. The numbers on the left side of the graph are VSWR values at the antenna terminal and the numbers on the right side of the graph are VSWR values with 50 foot of RG-214 coaxial cable between the antenna and the slotted line.

Figure W-3 is the antenna vertical radiation pattern at 127 MHz. This pattern shows a vertical beamwidth of 58° and a 22 dB front-to-back ratio. Figure W-4 is the horizontal radiation pattern which shows this antenna has a horizontal beamwidth of 86° at 127 MHz.

The antenna gain measured 10 dB above the standard gain dipole (+10 dBd or +12 dBi) as shown by the standard gain antenna dot on the vertical radiation pattern.

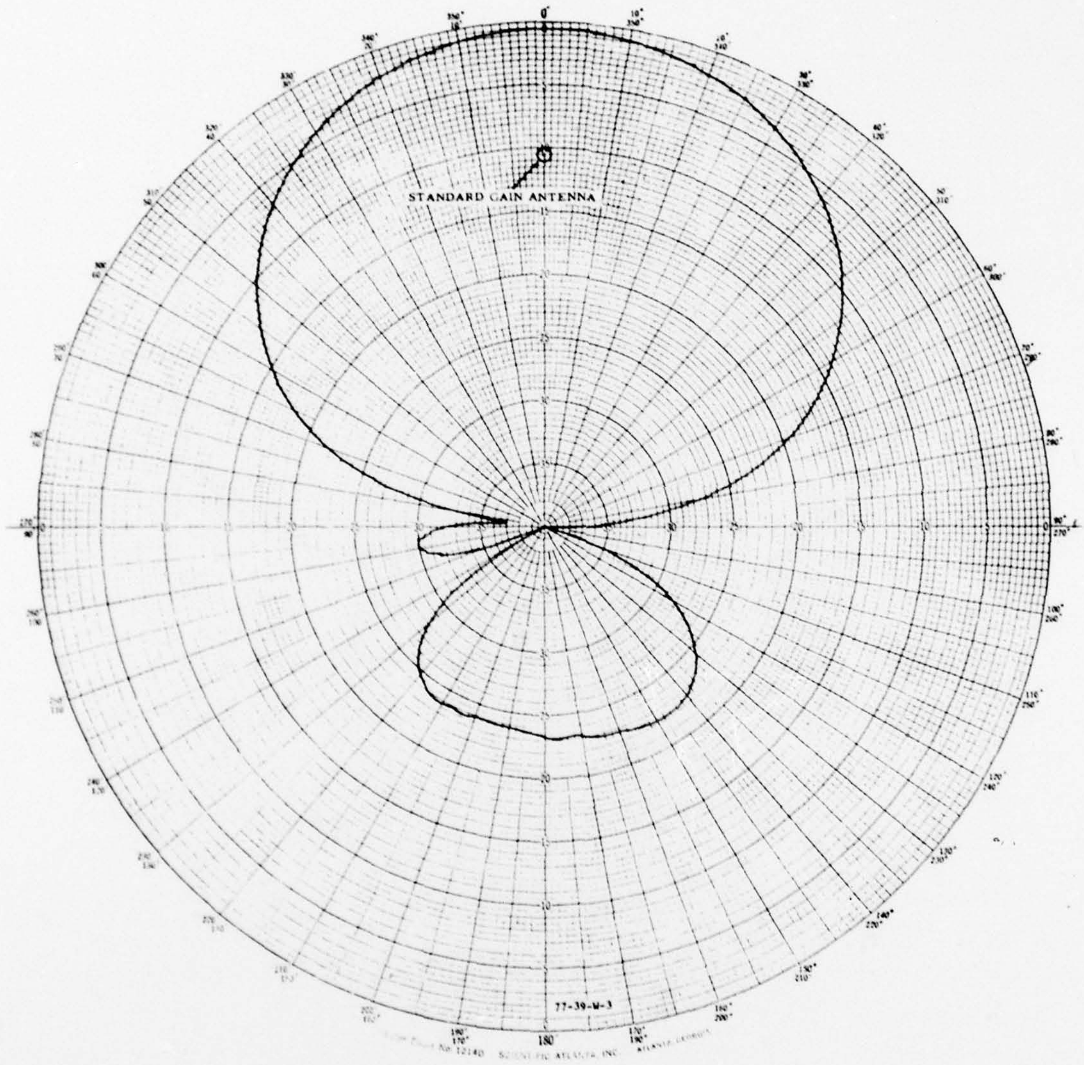


FIGURE W-3. Y-41-149 VERTICAL RADIATION PATTERN

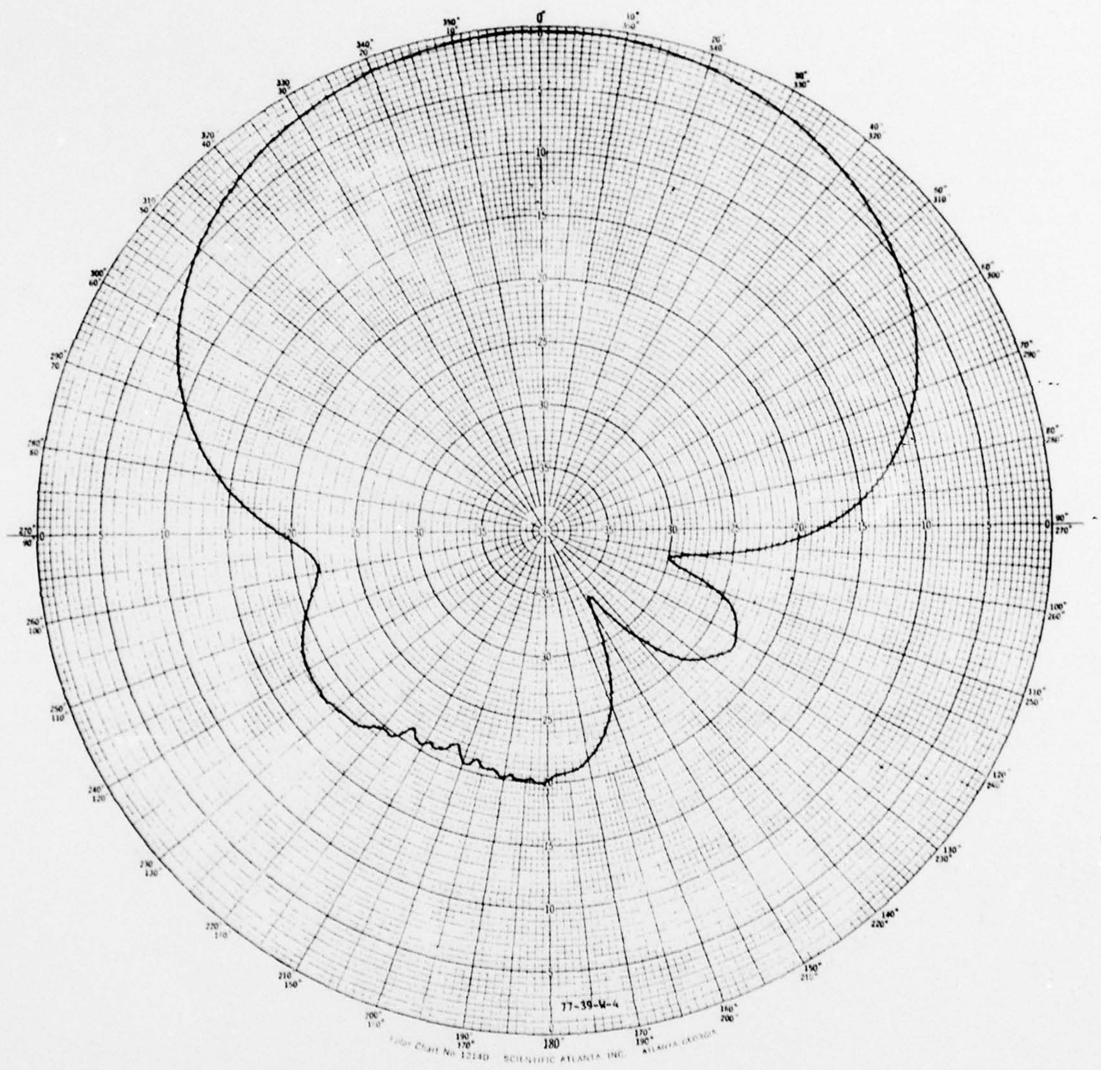


FIGURE W-4. Y-41-149 HORIZONTAL RADIATION PATTERN

APPENDIX X

TACO D-2261 VHF GAIN ANTENNA

The D-2261 antenna shown in figure X-1 is a vertically polarized omnidirectional gain antenna that was designed to operate across the VHF A/G communications frequency band of 118 to 136 MHz. This antenna was manufactured by the Technical Appliance Corporation, Sherburne , New York, and cost $1,110.00, weighs 14 pounds and is 142 inches long. The antenna elements are sealed inside a 1 1/2 inch diameter filament wound fiberglass enclosure which has a molded fiberglass clamp at the base of the antenna for installing the antenna on a 3-inch diameter support mast.

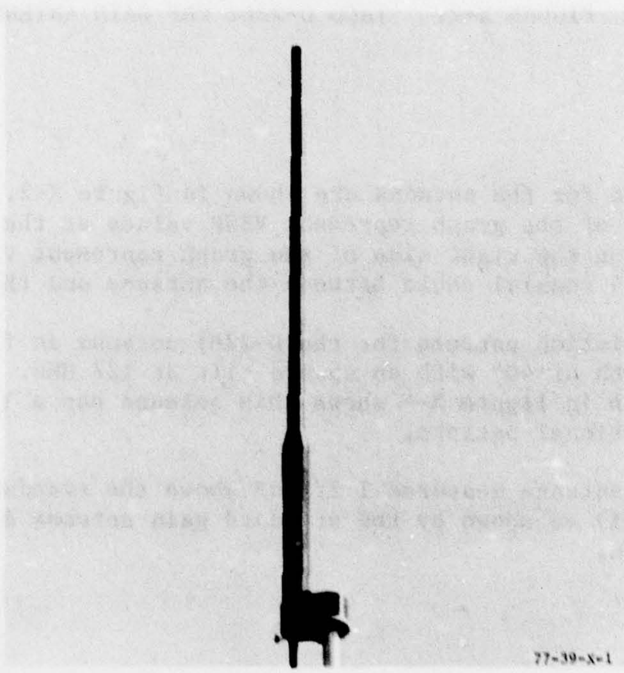


FIGURE X-1. D-2261 VHF GAIN ANTENNA

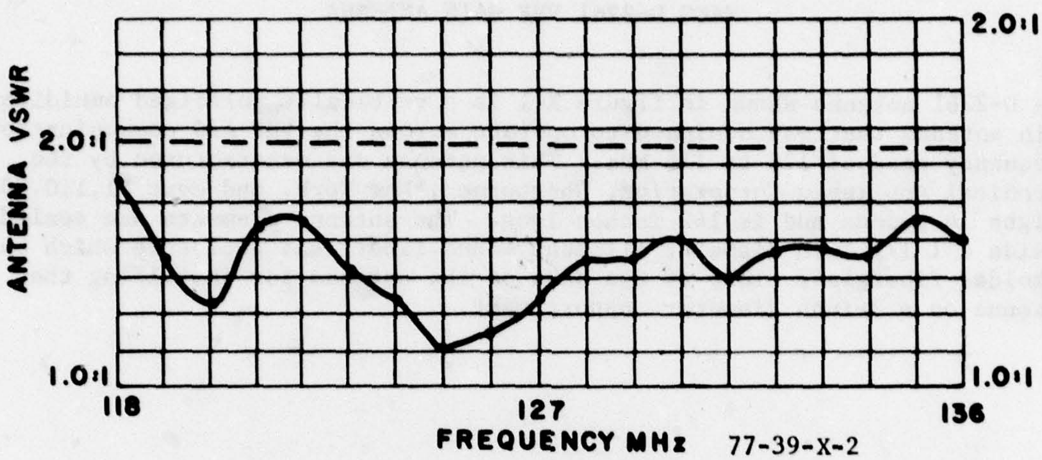


FIGURE X-2. TACO D-2261 VHF GAIN ANTENNA

VSWR measurements for the antenna are shown in figure X-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with 50 foot of RG-214 coaxial cable between the antenna and the slotted line.

The vertical radiation pattern for the D-2261 antenna in figure X-3 shows a vertical beamwidth of 40° with an upward tilt at 127 MHz. The horizontal radiation pattern in figure X-4 shows this antenna has a 1 1/2 dB variation in its omnidirectional pattern.

The gain of the antenna measured 1 1/2 dB above the standard gain dipole (+1 dBd or +3 dBi) as shown by the standard gain antenna dot on the horizontal radiation pattern.

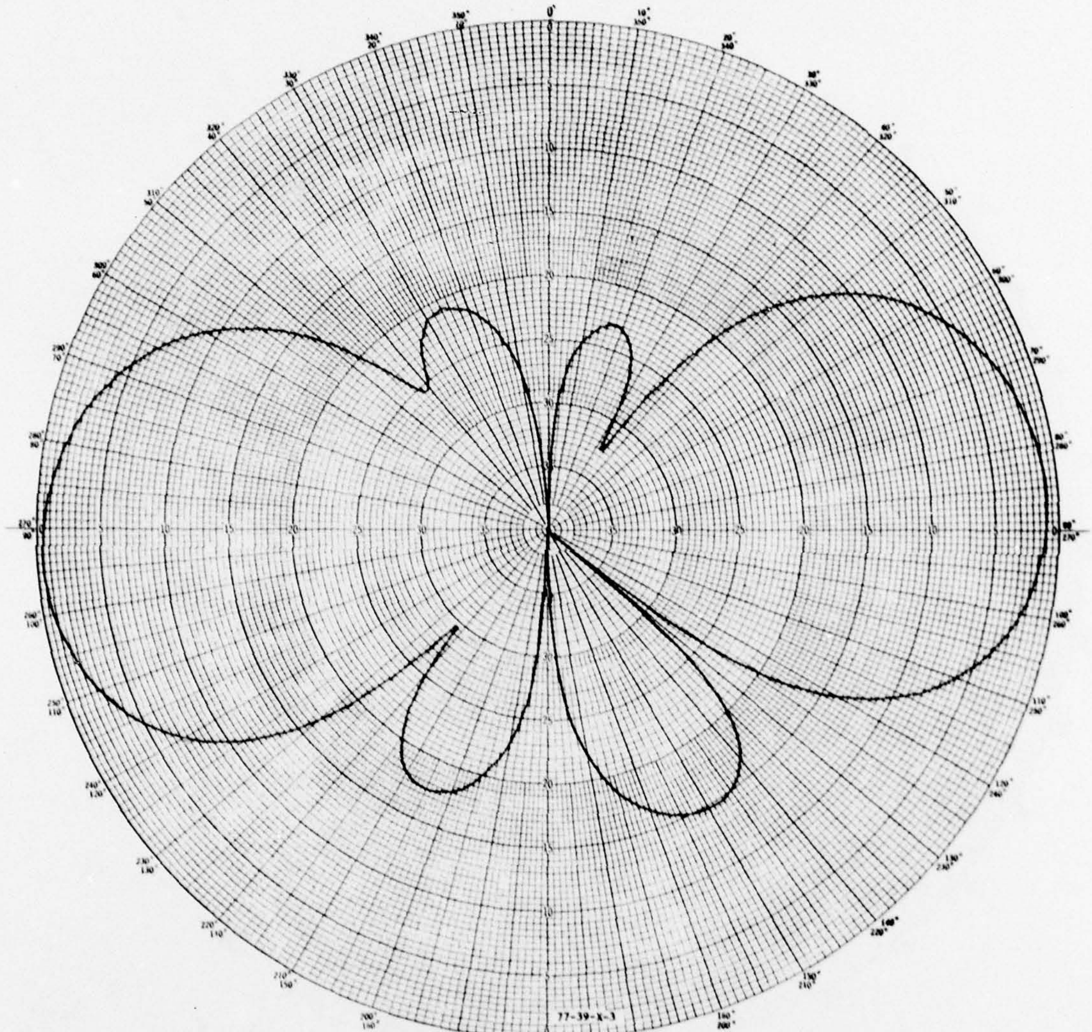


FIGURE X-3. D-2261 VERTICAL RADIATION PATTERN

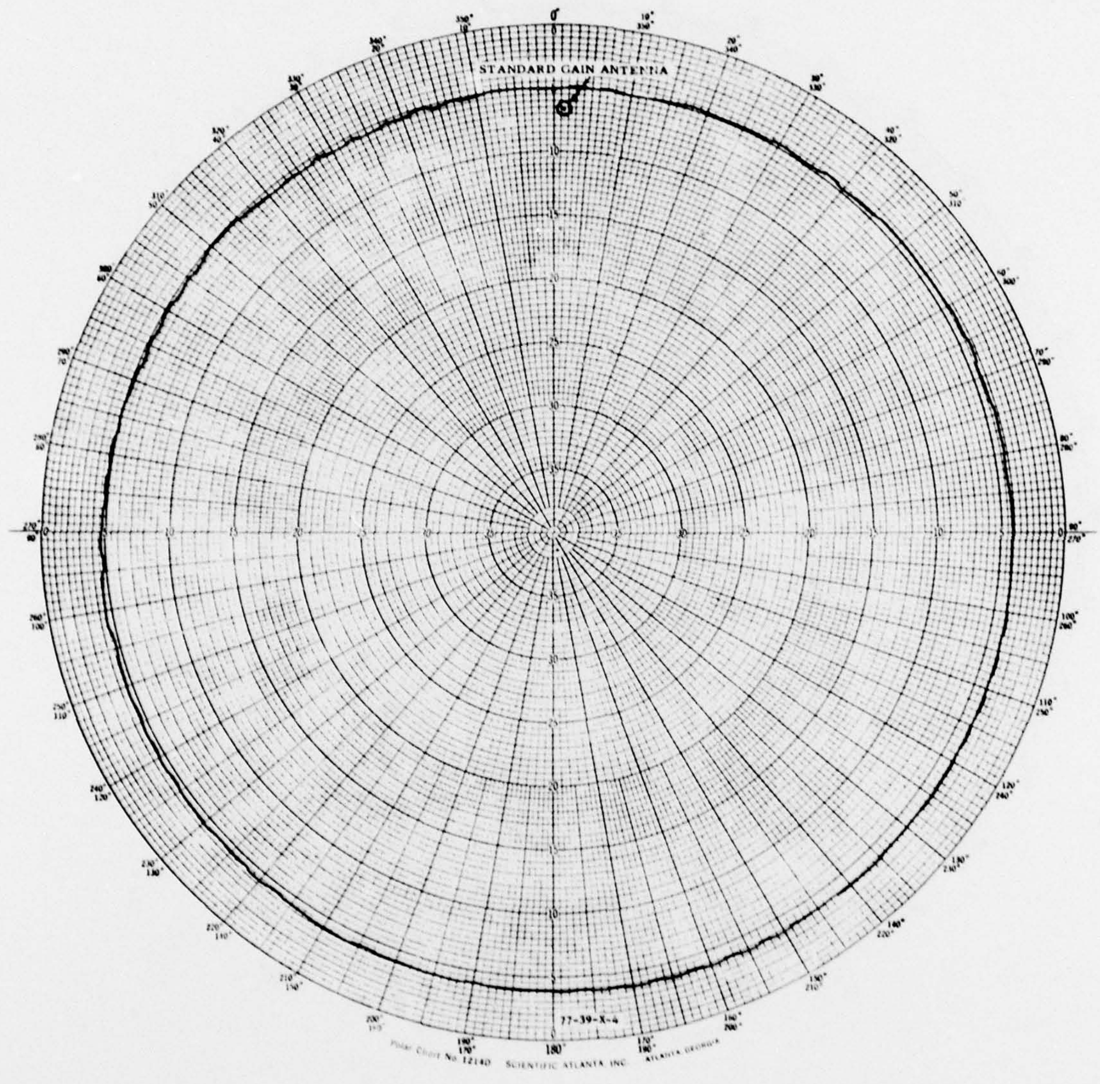


FIGURE X-4. D-2261 HORIZONTAL RADIATION PATTERN

APPENDIX Y

TACO D-2262 UHF GAIN ANTENNA

The D-2262 antenna shown in figure Y-1 is a vertically polarized omnidirectional gain antenna that was designed to operate in the military A/G communications frequency band of 225 to 400 MHz. This antenna was manufactured by the Technical Appliance Corporation, Sherburne, New York, and cost $975.00, weighs 5 pounds and is 68 inches long. The antenna elements are sealed inside a 1 1/2-inch diameter filament wound fiberglass enclosure.

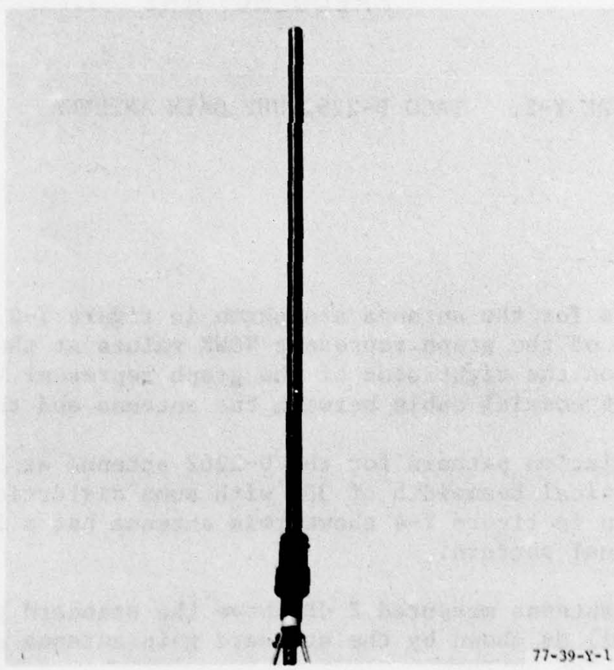


FIGURE Y-1. D-2262 UHF GAIN ANTENNA

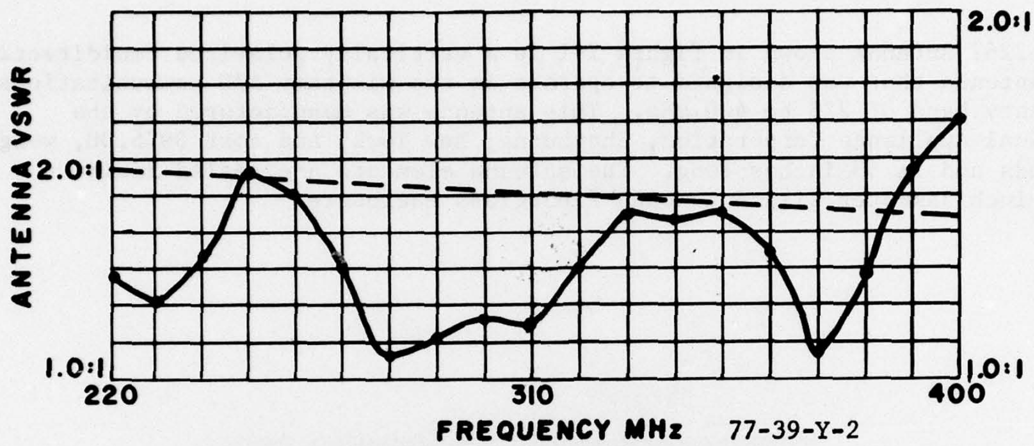


FIGURE Y-2. TACO D-2262 UHF GAIN ANTENNA

VSWR measurements for the antenna are shown in figure Y-2. The numbers on the left side of the graph represent VSWR values at the antenna terminal and the numbers on the right side of the graph represent VSWR values with 50 foot of RG-214 coaxial cable between the antenna and the slotted line.

The vertical radiation pattern for the D-2262 antenna at 300 MHz, in figure Y-3, shows a vertical beamwidth of 30° with some distortion. The horizontal radiation pattern in figure Y-4 shows this antenna has a 1/2 dB variation in its omnidirectional pattern.

The gain of the antenna measured 2 dB above the standard gain dipole (+2 dBd or +4 dBi) as shown by the standard gain antenna dot on the horizontal radiation pattern.

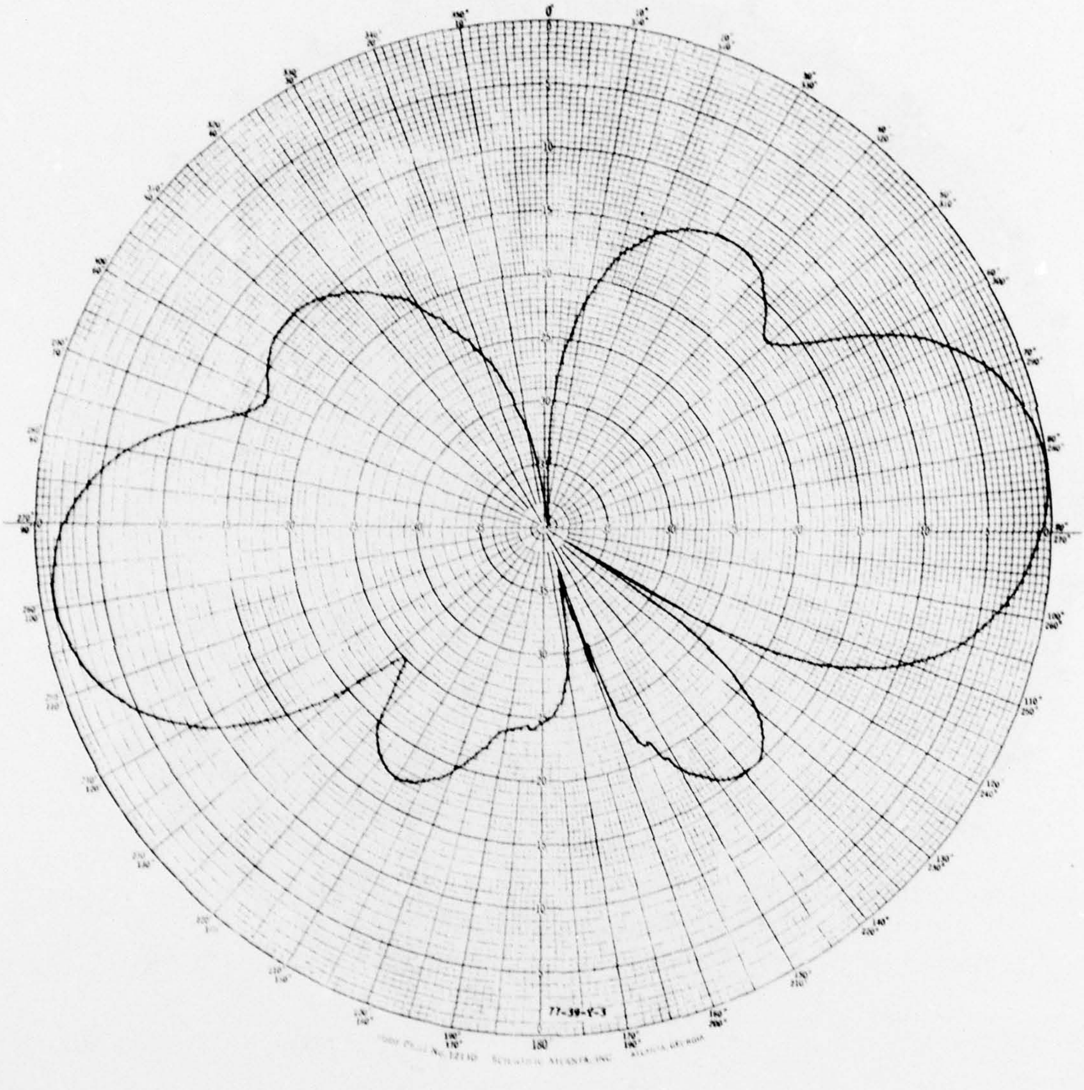


FIGURE Y-3. D-2262 VERTICAL RADIATION PATTERN

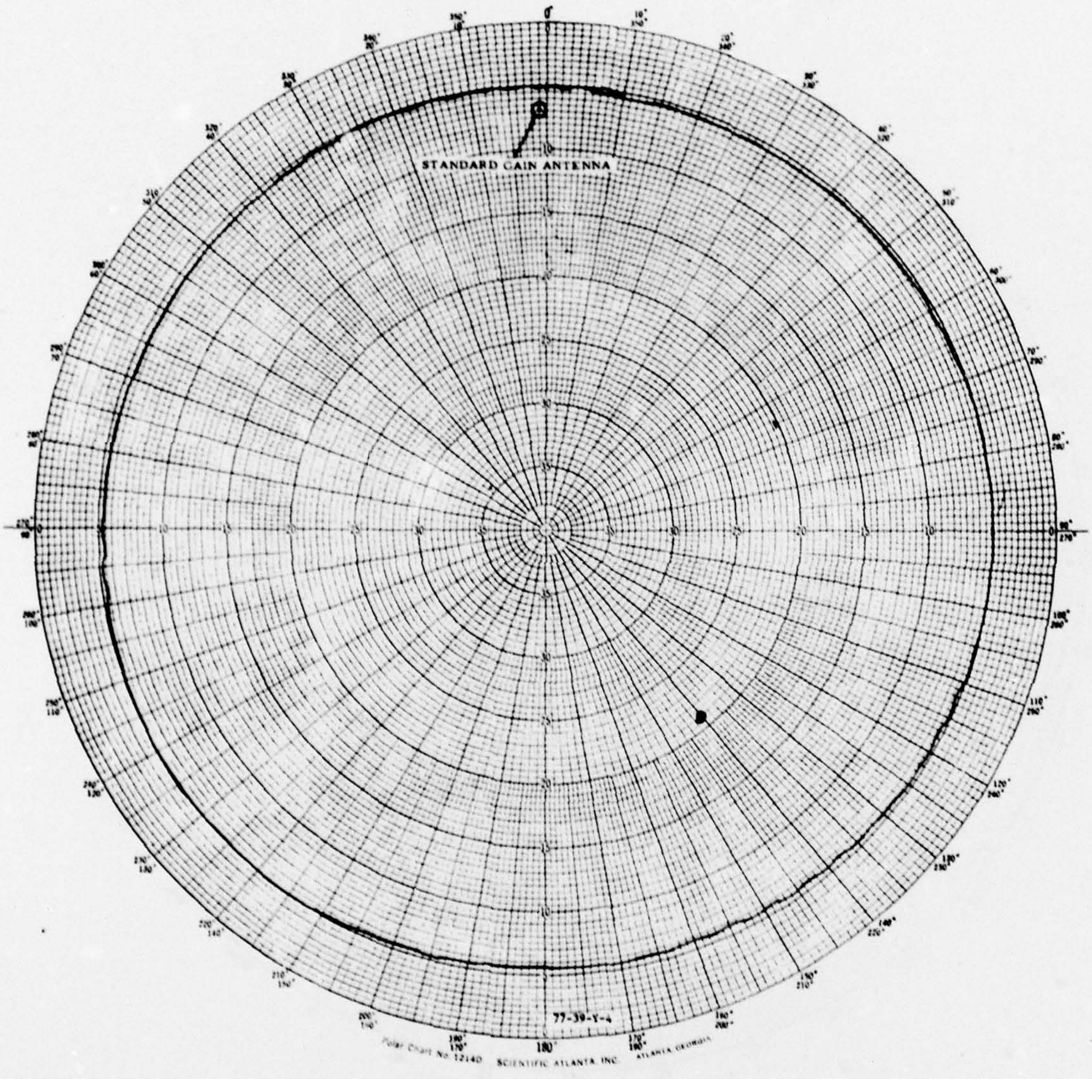


FIGURE Y-4. D-2262 HORIZONTAL RADIATION PATTERN